THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. CXII. No. 2479.] LONDON, NOVEMBER 15, 1910. [62ND YEAR. PRICE 6d.

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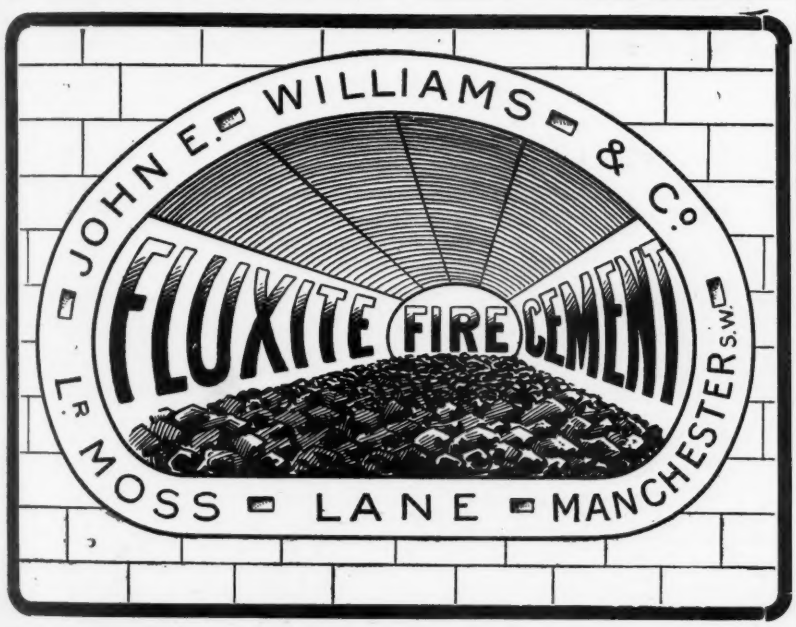

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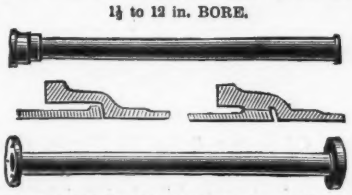

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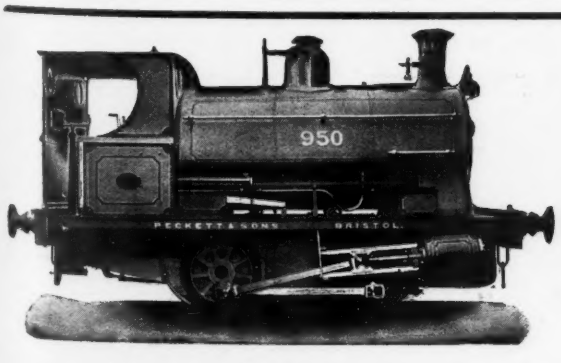

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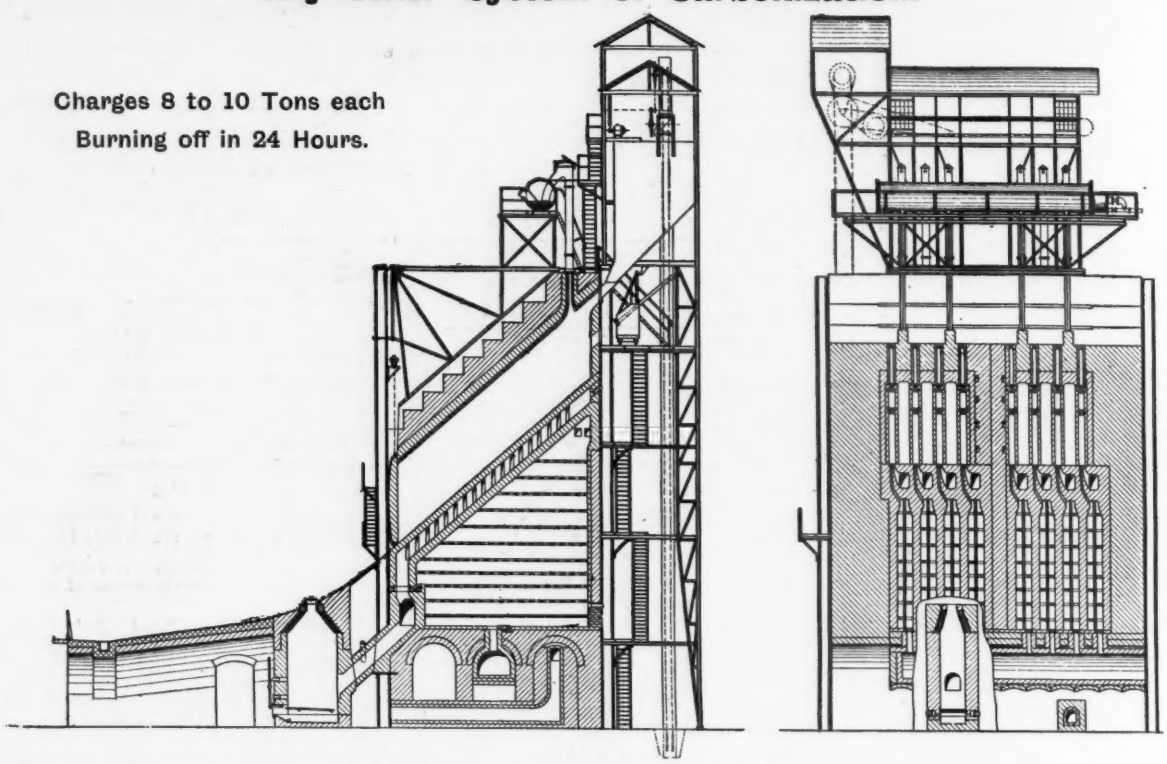

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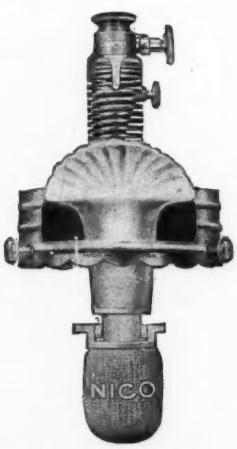

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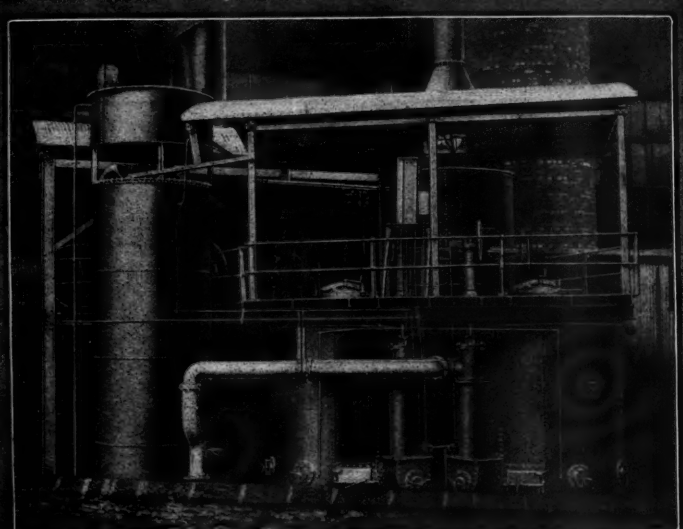

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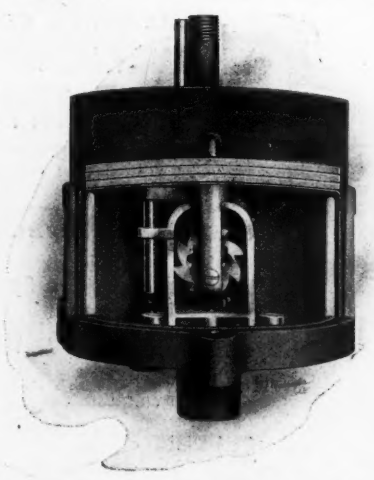

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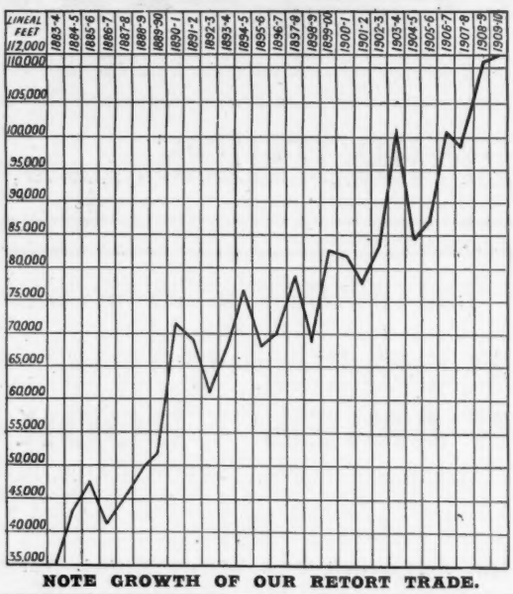

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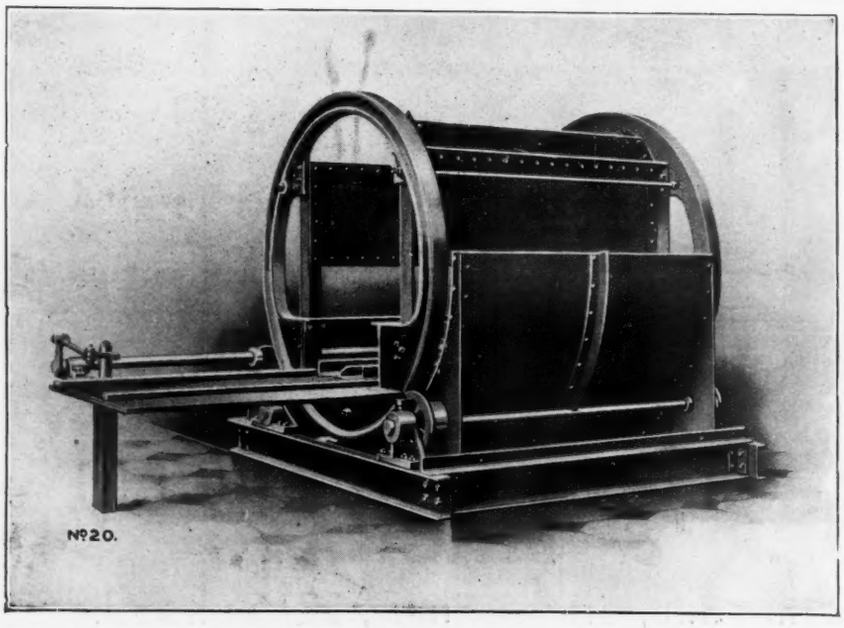

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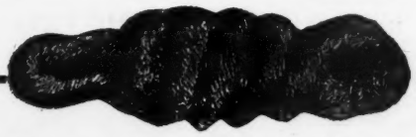

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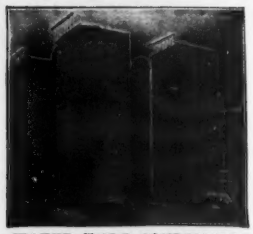

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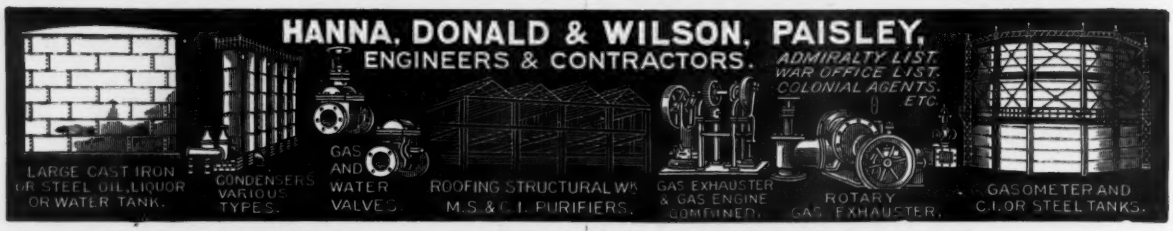
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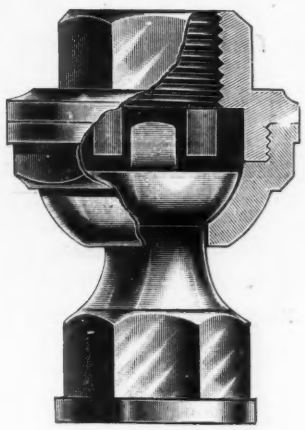

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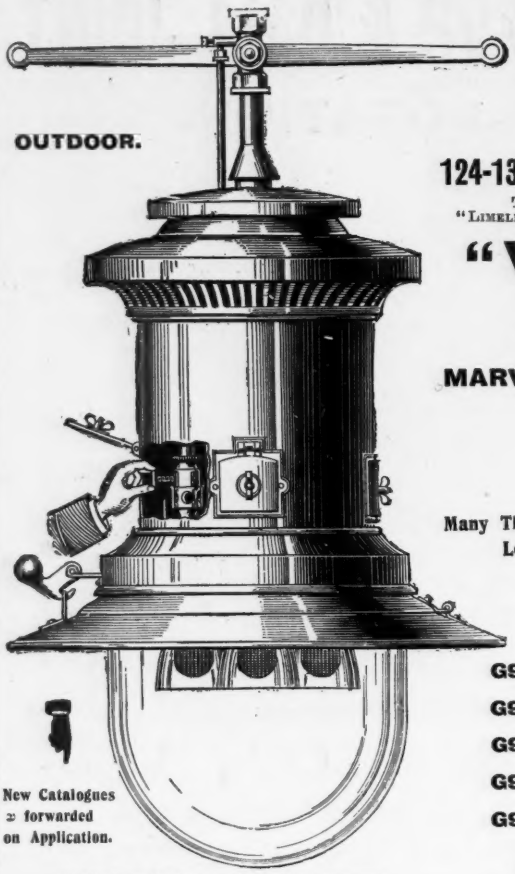

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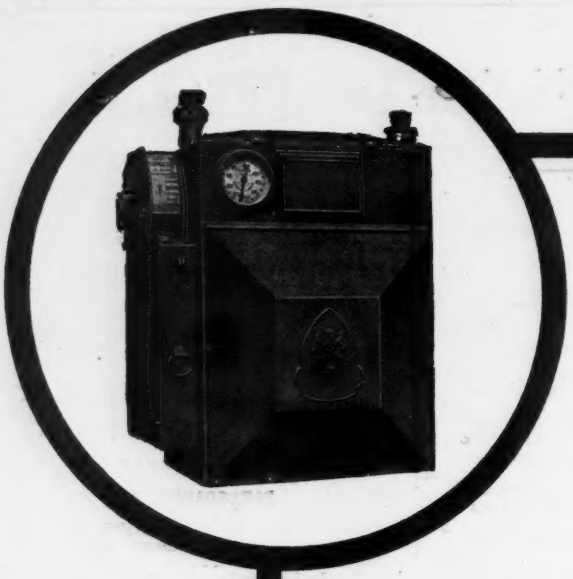

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EDITORIAL NOTES—GAS, &c.

Efficiency of the Inverted Burner.

Fixed or Adjustable Gas and Air Supplies.

THERE was a truce to controversial commercial questions affecting lighting, when, at the meeting of the Illuminating Engineering Society, last Tuesday, Mr. F. W. Goodenough, the Controller of Gas Sales of the Gaslight and Coke Company, read a paper, prepared in the most general terms (evading all polemical trading subjects, and refusing even nominal distinction to the newest of modern types of high and low pressure lamps), on the brilliant advances that have been made in gas lighting. For once, and for the first time in the short history of the meetings of the Society, the voice of the electrician was still; and he gave full scope to all that could be said within the limits set by the author of the paper, without even a note of praise or a note of dissent or criticism. There is one thing that must be said in respect of the embargo placed upon himself and his subject by Mr. Goodenough (though the restraint must have been irksome to a nature that commercially has been largely moulded by the acute forces that are brought to bear upon him in his official position), that, as the responsible executive officer of a Company engaged—particularly at this time—in severe competition, in installing in immense numbers the newer forms of gas-lamps in the streets, and in raising to a height to which it has never been raised before, in the 100 square miles or so constituting the area of the Company, illuminating efficiency in the streets, it would have been against the interests of those he serves to have carried his subject beyond the purely technical aspects, or to have touched upon points that are the subjects of both settled and open contract. Upon this self-imposed and necessary restraint under his peculiar circumstances, Mr. Goodenough has our sympathy; but nevertheless it was a good tale that he had to tell. It was a tale that put under complete seal those whilom pessimists and prophets who pronounced the approaching ostracism of gas as a lighting agent; it was a tale that disclosed, by contrast with the order of things that existed at the dawn of electric lighting, flights in efficiency that have astonished even those of the most optimistic tendency among the technicians of the gas industry; it was a tale that told of a new era in lighting having set in for the gas industry, with attendant possibilities too great for prognostication in any shape or form. With relatively so little of the thermal energy of the gas expended in obtaining the lighting efficiency of the present time, there is in the waste a reserve to which the aid of science may be evoked to show the path to profitable utilization. Let those among our competitors who will not acknowledge stubborn facts go their way; their acknowledgment is something with which we can dispense in the position in which we find ourselves, but acknowledgment will come in due time by the sheer force of circumstances.

In the paper and in the discussion, there was complete concord in placing the inverted gas-burner at the head and front in efficiency of gas lighting to-day, both with high and low pressures. The reasons for pre-eminence are being sought; and various theories are presented in the paper and discussion. The most obvious causes are those that were naturally grasped first; and these were duly submitted. Observation of the flame, in a well-constructed burner, shows that it is a concentrated one, having a high flame temperature; and observation, too, shows that it is impossible for the gas and air mixture to escape being heated prior to reaching the point of combustion. It is also obvious, from a mere consideration of the construction of the burner and from observation, that whereas with the upright burner useful lighting rays were dissipated above the horizontal, now they have been largely transferred to below the horizontal, and are being brought to bear in the most serviceable of all directions. But the most interesting theory, and one which has not so far as we are aware been suggested before, for the greater efficiency of the inverted burner, was introduced by Mr. Carpenter; and he seems pretty confident of his ground in this matter. To put it briefly here (his fuller remarks on the point will be found in our report of the discussion), it is this: With the upright burner, the particles of the flame that are most active in promoting the incandescence of the mantle are carried with considerable velocity upwards, and are not allowed time to effectively perform their work; whereas with the inverted burner there is, being downward, a retardation of flow, and, by the time the active particles reach the bottom of the suspended mantle, they come to (so to speak) a pause, before taking an upward course to escape in the spent products. In this way they are given longer time to do their work. It is a pretty theory, which, at any rate, is acceptable on common-sense considerations, subject, of course, to scientific ratification. It may be suggested the point is one that would serve as a practical subject for investigation by the Gas Engineering and Fuel Department of Leeds University.

Here we are confined to one or two prominent matters that transpired at the meeting. Technically, in the discussion, Mr. Carpenter's contribution was the most important. The theory advanced by him, as already alluded to, was one point; but as important, if not more important in the practical sense, is the (as it were) challenge that he has now thrown down in favour of non-adjusting burners as opposed to those with either or both gas and air adjustments, available for use at any time. But let there be no mistake about Mr. Carpenter's plan, which he has put into large use in South London, and is going to offer to the private consumers in the district (the necessary burner having now been developed) this winter. The burners, while non-adjustable after they have left the hands of the suppliers, are adjusted, in regard to the area of the air apertures and the passing capacity of the gas nipple, to the conditions under which they are to be used before being supplied to street-lamp or to private consumer. Mr. Carpenter does not make such a proposal as this, and put it into such extensive practice as he has done, without being very sure of his grounds. But there will be many who will be sceptical as to whether his proposal will have any general application outside his own area, and as to whether the disadvantages will not greatly outweigh the advantages. A straight coal gas is supplied in South London; but that is not the usual condition in other supply districts. Composition varies; and, even with straight coal gas, it must vary during the periods of transition in carbonizing practice from comparatively low makes per ton to the higher makes. Pressures also vary; but not so much as formerly during the lighting hours. There again, as Mr. Goodenough and Mr. A. E. Broadberry both pointed out, the tendency of pressure is upwards, and this introduces a variation of condition that is gradually growing. However, whatever changes in gas supply there may be, fortuitous or premeditated, the burner with fixed conditions removes from the consumer all power of making any readjustment. And in cold blood, Mr. Carpenter holds that this is the best thing that can happen. It follows that the standardizing of the burner demands the standardizing of the gas supply within limits; otherwise there will be much trouble. And in this way the gas supplier imposes on himself delimitations that will bring him difficulty. But perhaps we are considering the question without any sufficient knowledge as to the new burner's capabilities; and it would be interesting to know whether there are points in the quality of the gas and in the pressure between which the burner will give a fairly constant duty, as tested photometrically, in the South Metropolitan Gas

Company's district and in a district where the burner has been adjusted for a mixed gas. Seeing, too, the amount of attention such a burner must necessarily receive for adjusting it to a certain set of conditions, it would be interesting to know how stands its cost in comparison with an ordinary burner having adjustable air and gas supplies.

To the present we cannot see (though open to conviction) that any good case has been made out for the burner with unalterable gas and air supply. Given a burner with adjustment devices, when these are set to impart the maximum illuminating power, what advantage over this will a fixed conditioned burner possess? We fail at the moment to see any, unless a blessed state of perfection in the matter of uniformity and constancy rules throughout a gas-supply area. What disadvantages are there to the consumer? The power of adjustment is removed, together with the ability to effect an easy clearance of the gas-nipple when required without dismantling the burner. Mr. Goodenough made this latter point in replying to the discussion. We know of inverted burners in more than one house of the South Metropolitan Gas Company's area that are all the better for having a needle regulator attached. The burners are adjusted for both gas and air supply to a nicety to get the maximum efficiency. There comes a time, however—the straight coal gas of the South Metropolitan Company notwithstanding—when a vast improvement in the illuminating efficiency of the burners is secured by the clearance of the nipples; the restoration being effected by simply turning the regulating needle up and down two or three times. Consumers who have accustomed themselves to this rapid means of restoration of illuminating duty, will want to know what advantage they are to gain as compensation by adopting burners that remove this labour-saving power from their hands. All gas consumers are not unintelligent; and all gas consumers do not want to be put under—shall we say, obliged to be put under?—the Company's maintenance system. The inverted mantle and the needle regulator have greatly reduced the cost of maintenance and labour to the private consumer. Mr. Carpenter spoke of the dust in the air of London. In this connection it would be interesting to know something as to the relative costs of labour, or the number of street-lamps that a man can in a given time put into fit working condition with, respectively, fixed conditioned burners and burners with gas and air adjustments.

These are merely points that occur on a first consideration of the matter. But now that Mr. Carpenter has given prominence to his advocacy of fixed gas and air supplies to burners, the matter is bound to obtain a wider discussion than it received last Tuesday. Let it be remembered, however, that Mr. Carpenter's experiments extend over the past eighteen months, and that he has at his back a large experience of the burner in South London. But no one would regret more than he if these facts deterred anyone from stating his views. Argument and experience combined form the best path along which to get to the bottom of a matter of this kind.

Livesey Advisory Committee and Gas-Fire Research.

THE hope was expressed in the "JOURNAL" for NOV. 1 that the departure of Mr. E. W. Smith, the Chemist to the Gas-Heating Research Committee, from Leeds to Birmingham would not mean any suspension of the work of the Committee; but almost before the printing of the page in which that hope appeared had been completed, information was to hand that the Council of the Institution and the Gas-Heating Research Committee had determined that, at any rate for the present, the work should be discontinued. As the information was not official, and there was no particular urgency in making the announcement, it was deferred until after the conference arranged with gas-fire manufacturers for last Wednesday at the Leeds University. It has been thought opportune to suspend the work for the present under existing conditions; and it must be quite evident to all who give the matter serious consideration that it is not an easy thing to get anyone to readily pick it up, and conduct it from the point at which Mr. Smith (who has shown splendid aptitude for it) has relinquished it. But this does not, nor does the dissolution of the Gas-Heating Research Committee, necessarily imply that gas-heating research is to be permanently abandoned at the Leeds University. Whether or not Mr. Smith had continued at Leeds, there is little question that the research on its recent lines would have been, and not at a very distant date, brought to a termination. But that research bearing upon gas heating should for ever be banished from the Leeds University would, it is obvious, be entirely opposed to the purposes and objects of the Gas Engineering and Fuel Department; and it becomes now, as Professor Smithells (without pledging himself to any particular action at this juncture) pointed out on Wednesday, entirely a matter between the Livesey Advisory Committee and the University Authorities. Upon that Committee, the Gas Institution and the Society of British Gas Industries have a good representation; so that we fail to see that there is any good cause for agitation in regard to the matter of the suspension. The interests of the gas industry are in good hands; and there may be full reliance that, in their deliberations over the work of the Gas Engineering and Fuel Department, the Livesey Advisory Committee will not lose sight of practical problems that still require solution in relation to the gas-fire.

To the point to which Mr. Smith has carried his work, there will be some further report at next year's meeting of the Institution in Glasgow. An interim statement on various details, however, was made by him last Wednesday; and in it several hints are to be picked up by gas-fire makers. It was also clear that he has been examining the various introductions of the manufacturers this season, having the common purpose of increasing efficiency, in order to see how far the object has been realized. But the main point for present consideration is as to whether there is at the moment further work that can be usefully prosecuted at the University in connection with gas heating. We cannot help feeling, after what was said at the meeting on Wednesday, that there is. Mr. Smith thinks that gas-fire research has only just commenced; but it is also his opinion that further work requires greater facilities than can be obtained at the University. That is a point that the Livesey Advisory Committee must soon take into consideration. But that the matters for investigation in connection with this large subject have not been exhausted, within the capacity of the University, by what Mr. Smith has done, is easily gathered from the speeches at the conference; and, in the indications these afforded, the conference was not barren of good, and we are not without hope that it will have influence on future work. To give illustration. It was the view of Professor Cohen that a great deal of work has still to be done; one of the most important problems for solution being as to the relation between temperature and radiation. Mr. Smith himself pointed out that the thickness, composition, porosity, and form of fuel is a subject for special experiment. There are practical difficulties in this regard; but surely in collaboration with the manufacturers of such fuel, the difficulties would not be insurmountable. There is also the subject of surface combustion in relation to the "fuel" and fire-brick. Mr. H. M. Thornton suggested the point that gas-fire makers desire to see some standard of test of gas-fires adopted by gas-supply authorities generally, so that the makers may know under what standard conditions their apparatus would be tested—thus affording them some guidance in their work. This view was endorsed by Mr. A. P. Main. The variation of the shape of flame by using the gas supplied in different towns is a question suggested by Mr. J. H. Brearley as worthy of investigation for future direction in burner design; and he also pointed to the meagre knowledge that exists as to the heat conductivity of "fuels."

These are only illustrations of suggestion; but we submit that they, without going further, show that there is useful work in connection with gas heating which it is within the power of the department at Leeds to take in hand, independent of what is being done by the gas-fire makers. The latter are themselves more and more introducing into their work scientific assistance; but in each case, naturally, they work on their own lines and to their own ends. For this they are to be applauded, as it all means initiative—successful or attempted—in the cause of progress. But if we take the results of individual work of the firms to date as embodied in their productions, and place them side by side for inspection, it is seen that there is anything but uniformity of view. Mr. Smith by his work independent of the makers, having their various productions at his command, has done something to adjust the differences. On all grounds, we hope the Livesey Advisory Committee will take counsel with the Leeds University authorities, so as to see what can be done to further the important and helpful work that, as seen above, has not yet reached a point that justifies it being laid aside until again some practical question arises for the penetrating searchings of science.

Extension of Sulphate Manufacture to Small Works.

SMALL works in isolated position (though, as a rule, well situated for the local disposal of sulphate of ammonia) have hitherto been in a disadvantageous position for making a profit, compared with large works, from the ammonia they produce, simply on account of the small magnitude of their operations, and the cost of the conveyance of ammoniacal liquor to places where it could be worked up economically; and, as a matter of fact, the ammonia to them has been nothing but a source of nuisance and cost. But it need be so no longer, as simple ways and means have been found to give them the profit and relief that must be desired. The Managers of small works look from the distance on many things which seem only applicable to the larger undertakings with admiration not unmixed with envy; and sulphate of ammonia manufacture is one of these things. It will therefore be, we doubt not, that they will hail with some satisfaction the advent within their own province of a sulphate plant which has been already put into practical operation, and at gas-works between the two widely separated points in annual gas production of 5 million cubic feet and (say) 26 millions—respectively at Wareham and Dunstable. It was the pleasure of Mr. Philip G. G. Moon, of Bournemouth, to present the information concerning the plants at a meeting of the Southern District Association last Thursday; and he must be complimented upon his (so far as recollection serves) maiden effort in this direction, and on having for his subject a matter that represents distinct progress for the smaller undertakings of the gas industry.

The basis of this process is the absorption of ammonia from the gas by dilute sulphuric acid—a process that is not new, as shown by Dr. Harold G. Colman in the discussion, but one which has been surrounded by many practical difficulties in application in connection with town-gas manufacture. As a matter of fact, the fundamental part of the process is so old that Mr. A. E. Broadberry was able to refer to the use of sulphuric acid for this very purpose (and to quote substantiating evidence from "King's Treatise") by Mr. Alexander Croll, at the Tottenham Gas-Works in the forties. Mr. Croll appears to have attained some amount of success; but the sulphate produced was of a bad colour. The disclosure as to antiquity is good and interesting so far as it goes. But the fact remains that the process as applied by Mr. Croll was discontinued, and that the product was not all it should have been in regard to colour. The Tottenham Gas-Works were but small in those days, and so are the gas-works for which the new plant of to-day is primarily intended. But where Mr. Croll was unsuccessful, the Chemical Engineering Company have been successful; and the resultant product of the process is of good colour. From what Mr. Broadberry remarked, it may be conjectured that it was tar that affected the purity of the sulphate in Mr. Croll's time. But in the plant as now brought before us this is overcome by the provision of means of filtration; and with the weak solution of sulphuric acid that is employed in it, we imagine there would be very little deposition of tar. The first point is that the new and simple plant Mr. Moon introduces to us successfully yields a vendible product, and converts a source of trouble into one of profit.

It would be unfair to contrast with too much severity the economic aspects in relation to the working results of this plant with those of the long-established plants on the ordinary lines of operating method. But it may be held that distinct progress is recorded when plant of the kind is productive of advantages where the old process was incapable of being used, and when the differences between the results and effects of such a plant and the more economical results and efficiencies of the larger and ordinary plants have been reduced to the narrow compass that are revealed by Mr. Moon in his paper. The plant has a low initial capital cost; it is so simple that it can be operated, after brief instruction, by a novice; the amount of attention required is small (in fact, at Dunstable it has not occasioned any increase in the works' staff); and there is an all-round benefit from its adoption, which (on the testimony of Mr. Harold Woodall and Mr. Moon) can be summed up in the two small words "it pays." There are no complete figures yet available as to working expenses; but from the little plant at Wareham, with a selling price of £11 per ton for sulphate, a net profit of £7 per ton is anticipated. The quantity of effluent—this is an important consideration—is also small in comparison with the ordinary method of working. The most vulnerable point for criticism is that of plant depreciation. But here again there is sufficient information to give every confidence. It is common knowledge that many difficulties have been encountered in designing a practical process for ammonia recovery in which sulphuric acid is employed; but there is an amount of experience which gives good warrant for saying that the use of a weak sulphuric acid solution will not have any alarming effect upon the lead elements of the plant.

Several trifling adverse suggestions (it would be strange were it not so) might be made in regard to the process. There is, for instance, the effect on the illuminating power of the gas. But here we are dealing with an acid that is kept below a strength of 4° to 5° Twaddel. There is the question of the effect upon purification of the complete removal of the ammonia from the gas. There again, however, Mr. Moon and Dr. Colman give satisfactory answers. In the small Wareham plant only the free ammonia is dealt with, and there is a loss in the virgin liquor of no less than the equivalent of 1·1 lbs. of free ammonia and 4 lbs. of fixed ammonia. But with such limited operations, the greater economy lies in this waste. In the Dunstable plant the range of operations makes the fixed ammonia worth recovery. But whatever point can be raised that is apparently derogatory to the new plant and process as compared with the old situated in works of comparatively extensive, or fairly extensive capacity, there are presented by the newly introduced process ample compensations for the proprietors of works of small to medium gas outputs. There is one question that was not asked in the discussion, which suggests itself at the moment. It is: Is there any contamination of the sulphate by sulphur through the action of sulphuretted hydrogen on the acid?

The process is so succinctly described and explained by Mr. Moon that it would be waste of time to here attempt to reduce the description to greater brevity. But the introduction it has received will enlist almost immediate consideration from those responsible for the most economical working, with freedom from nuisance, of small gas undertakings; and sulphate of ammonia manufacture will no doubt be shortly conducted in places where hitherto there has been little hope of it being carried on.

Higher District Pressures.

LATTER-DAY developments in gas supply in respect of the volume, diversity of demand, and extension of the hours of heaviest load have had quite a revolutionary effect on district pressures; and there is nothing in the whole of the technical requirement and responsibility of the time in connection with a gas undertaking that calls for greater attention and acumen than this. This applies to gas undertakings both large and small. Need any gas man be told that the design and arrangement of much gas plant, designed and erected in a day in which there could not be prediction as to the upheavals in gas supply and methods of utilization of the future, are, without large conversion or supervenient aid, insufficient for the needs of the time. Under existing circumstances (without auxiliary help), pressure at the consumers' meters is defined and limited by the conditions of the canalization; and the highest available constant pressure from the works is that which can be thrown by the lightest uncupped holder. The existing conditions are those which have to be dealt with; but the existing conditions are of such variety that it is difficult to prescribe any single plan that would be best for universal application to give what is requisite to-day—a higher pressure, and with the *plus* and the *minus* from the standard of uniformity reduced to the narrowest possible limits. The ideal standard is a uniform pressure throughout a district, with a permanent degree at the point of delivery to consumers. Beyond that gas suppliers cannot expect to go, though they may bring influence to bear in respect of internal fittings to ensure the minimum of fluctuation at the point of use.

This fairly expresses the general view of Mr. Thomas Price and the principal speakers in the discussion on his paper on "District Pressures," read at the Southern Association meeting last Thursday. It was a subject that lent itself to the expression of views and experiences roving over much ground. How to deal with the weak spots in a district by boosting (a system that is becoming the vogue with remarkable rapidity from large works down to those fairly low in the scale of magnitude) may be taken as figuring at one end of the discussion with the governing of consumers' incandescent burners at the other. But the main feature of the whole paper and discussion was the recognition of the need of higher and constant pressures, both in the interests

of consumers and the maintenance of a good reputation by the gas undertaking. And the view of the author is, and he is supported by Mr. Charles Carpenter and others in this, that the ideal system for obtaining what is required would be to keep a pressure throughout the district of supply in excess of the maximum pressure demanded for any purpose and in any place, and then govern down to requirement at every service. This would mean (save for variation caused by inadequate internal fittings) a constant pressure at any given point in a house.

It goes without saying that to realize such a condition of things means expense. But there is little doubt that this is what we are coming to. For such a purpose a reliable consumers' service governor would be required; and, in Mr. Price's opinion, its application would pay. Mr. Carpenter has found a governor that answers the purpose, and one in which accuracy and safety are the main factors of the design. He speaks of the cost of attaining this ideal condition of governing at every service, and, in the same breath, tells of the several thousands of the governors that have been already applied in South London. Service governors, for the outlet of consumers' meters, were in the old flat-flame days advertised for the securing of economy, and to protect the consumer against the supposititious fraudulent conduct of the gas manager in increasing the pressure to make "the meter wheels go round." To-day the service governor is advocated on the ground of efficiency. The distribution department now costs much more than of old; but gas prices are receding and dividends are maintained, and have an upward tendency. If higher pressures and service governors are the directions (combined with reasonable and approximately regular calorific power) of future supply efficiency, the expense must be faced as part of the price to be paid for assuring stability and fair profits on the capital embarked in the business. Changes of this kind do not come about with the swiftness of a *coup d'état*. The several thousands of governors in South London were not fixed in a day. They have grown to their present number gradually; and the number, Mr. Carpenter mentions, is rapidly increasing. Questions of policy in the gas industry have certainly a tendency to multiply; and the Southern Association discussion on this matter adds another to those already on the table receiving or awaiting consideration.

High-Pressure Shop Lighting.

"What Mr. A. E. Broadberry does not know about high-pressure gas lighting is not worth knowing" someone remarked at the Southern Association meeting on Thursday; and when the paper he then read on the subject—full of information of how to make high-pressure lighting a commercial success, and a combative force in the hands of a gas undertaking—is perused, it will be readily agreed that the commonplace quoted was not by any means misapplied. Record has already been made in the "Journal" of what has been done by the Tottenham and Edmonton Company in high-pressure gas lighting at the Alexandra Palace, and of the success that has attended the installation. But from the commercial point of view, the principal value of Mr. Broadberry's present communication will be awarded to the detailed narrative of effort that has resulted in schemes of co-operative shop lighting being launched, and immediately springing into a brilliant success, so much so that the tentative installation, which led to other isolated or independent installations, has grown to an extent that there has been, on the score of economy, a linking-up in one considerable area, with service from a central compressing-station. A well-lighted shopping street is undoubtedly an attraction; and time would be wasted to-day in trying to persuade tradesmen to the contrary. And when co-operative schemes such as those Mr. Broadberry tells about are introduced, no tradesman on the line of high-pressure pipes can afford to stay out, unless his premises are as brilliantly lighted as the others (though perhaps not so economically) by some other method. It is a good branch of business for a gas undertaking—both from the monetary and from the competitive point of view; and how to cultivate it is pointed out in the paper. The contribution, being so informative, is bound to incite others to go and do likewise; and that is not the least part of the intrinsic value attaching to its practical character. Any regret that there may be over the postponement of the discussion is modified by the fact that this will bring Mr. Broadberry to his feet again at a future meeting, to supplement, after further experience, the present information.

High-Pressure Lights in London.

From Victoria Street the new high-pressure gas-lamps, under the Westminster lighting contract, are being extended in the main thoroughfares as rapidly as possible. One of the most striking of the effects so far as the lamps have been erected is at the end of Parliament Street by the Houses of Parliament. This is an important spot; and one where at most times during the day there is heavy traffic. Our legislators this November and December sitting (which may be brief and momentous) will at any rate find their paths to and from the House—if not inside—illuminated in unprecedented manner. The Right Hon. John Burns, too, will be able to look out of the windows of the offices of the Local Government Board on a night lighting scene that will convince him as to the wisdom of his department exercising care over their sanctions for municipal electricity supply undertakings, and cautioning local authorities to be discreet in their money spendings in this direction. Turning to the City, inspection of the central trial suspension gas lighting in Cannon Street (some particulars of which were published last week) shows how thoroughly well the surfaces of the road and footpaths are lighted, apart from traffic shadows. Being in straight line with the centrally suspended flame arc lamps, comparison with them is readily made; and the palm for efficiency will not be conferred upon the latter by anyone making disinterested observation. Taking a perspective view along the street from the flame arc lighted section, the part of the street from Cannon Street Station to the London Bridge end of the thoroughfare is alive with light. Looking from the gas-lighted portion towards the flame arc section, the latter is distinctly dull in contrast. High-pressure lighting with the new inverted lamp has toned down the old meretricious characteristic of the flame arc lamp, the concentrated but oscillating effulgence of which was once upon a time regarded by electricians as representing the unsurpassable point in rational street lighting. We certainly thought our electrical contemporaries would ere this have published some curves constructed from the incomparable readings of the young men who pursue nocturnal investigations by the aid of illumination photometers. Surely they are losing a fine opportunity. Perhaps, however, it has been concluded that the present is an occasion when silence is golden. We are informed that there was an error in stating last week that the two burners in each lamp were of only 1000-candle power apiece. The figure should have been 1500 candles each burner.

Free Labour.

Some days ago, the National Free Labour Association held their eighteenth annual congress; and the time proved not to be inopportune for drawing attention to the fact that Trade Unionists, in spite of appearances, are by no means having things all their own way in the industrial world. The Free Labour Association boasts of over three-quarters of a million members—a not insignificant fighting force, when properly organized, as they seem to be under the leaders of this Association, for freeing workers from the necessity of abiding under a condition of things which many of them find irksome. The President, Mr. J. W. Roberts, explained the full meaning of the movement, when he told the delegates that he had always been a free workman, because he objected to tie himself down to drudgery for life by belonging to a Trade Union, and thus putting himself on an equal footing with men who were incompetent. He added that there were plenty of good workmen stuck fast in Trade Unions, absolutely committing industrial suicide by helping to keep the happy-go-lucky tribe of incompetents. This is a view of the matter which may be commended, for their most earnest consideration, to the workmen concerned. The advantages in some respects which, on the face of things, appear to be offered to workers who join a Union, are only too apt to prevent anybody who is not of a particularly inquiring turn of mind from looking closely into the possible disadvantages. However, even if the matter is put plainly before employees, it is to be feared that often they find themselves compelled to join the Union ranks, whatever may be their own feelings. It is the continual exercise of their power for the purpose of compelling to join the ranks those who wish to remain outside, which has been such an unwelcome feature of Trade Unionism. At present, in some branches of industry the Trade Unionists may have in their hands the means of enforcing their wishes on men and masters alike; but we look to the growth of the Free Labour Association, and the wide dissemination of

their views, to accomplish more and more as time goes on in the direction of altering this state of affairs.

And Free Workers.

Meanwhile, another style of "free" workers is attracting a larger amount of attention than the Association. We refer to the strikers in the South Wales coalfield, a section of whom—it is to be hoped, but a small one—have been behaving themselves in a manner which is exceedingly well calculated to alienate from their cause such public sympathy as it may previously have enjoyed. Disastrous as is the existing state of affairs to the coalfield, it may easily prove in the end to be still more calamitous to Trade Unionism. Refusing to carry out an agreement signed by the officials of their own Federation on their behalf, and later rejecting terms which were also accepted for them by their leaders, the miners have indeed drawn into the glare of publicity one of the strongest points against the Unions that can possibly be urged—namely, that while an agreement is binding on the employers, the labour representatives have no means of making it similarly binding upon the men. Rioting, looting, and the wilful destruction of valuable property have immeasurably weakened the case of the men; and we can imagine Mr. G. R. Askwith, of the Board of Trade, who visited Cardiff on Saturday for the purpose of interviewing the employers and bringing about a termination of the dispute (or disputes, for there appear to be several), found himself confronted with a particularly hard nut to crack. The present position is deplorable, and the outlook at the time of writing is even more threatening. Intervention may accomplish much; but there must be a point in the matter of concession beyond which it is impossible to go. Has this point already been reached without satisfying the demands of the men, and must the fight go on to a finish?

Personal.

Mr. H. M. THORNTON (of the Richmond Gas Stove and Meter Company, Limited), who has been Chairman of the Ilford Council during the past twelve months, was recently presented with his portrait in oils at a large and influential gathering of prominent townspeople. It has been decided that the portrait shall be hung in the Council Chamber of the Municipal Buildings.

Arrangements have been made with Dr. HAROLD G. COLMAN to act as Consulting Chemist to the Richmond Gas Stove and Meter Company, Limited. Dr. Colman will pay frequent visits to Warrington, and undertake the general supervision of the laboratory and research work relating to gaseous heating, in conjunction with Mr. L. Dixon, who has for several years been the Engineering Chemist to the Company. Further extensive alterations are being made to the Warrington laboratories in connection with this appointment.

Obituary.

Mr. JAMES BROWN, well known in the West of Scotland as a retort-setter, died last Thursday afternoon, at his residence in Hamilton, in his 54th year. In the setting of retorts Mr. Brown had few equals; and he carried out contracts of this description far and near. He succeeded to the business only a few years ago.

After an illness of four months, the death occurred on Monday last week, in his 74th year, of Mr. ALFRED PARKER GIBBONS. Some years ago, deceased was employed in the engineering department of the Phœnix Gas Company; and after the amalgamation with the South Metropolitan Gas Company his services were retained. He retired some ten years since.

The death is reported as having taken place on the 12th ult., of Professor JOSEPH FORSTER, Lecturer on Hygiene at the University of Strasbourg, and one of the Editors of the "Archivs für Hygiene." Deceased, who had attained the age of 66 years, was a distinguished pupil of Pettenkofer, and had devoted much time to the hygienic aspects of questions of lighting and heating and water supply.

The death occurred at "The Glen," Eastbourne, last Tuesday, of Mr. CHARLES AIRD, brother of Sir John Aird, Bart., and of the late Mr. Joseph Aird. Deceased was in his 79th year. He was formerly a partner in the firm of Messrs. John Aird and Sons. After a complete breakdown in health, he retired from the firm some 34 years ago; and since then resided on the South Coast. Before joining the above-named firm, he was for a number of years Lessee and Manager of the Kingston-on-Thames Gas-Works, and was also at one time a Director of the Crystal Palace (now South Suburban) Gas Company. As a partner in the firm of Messrs. John Aird and Sons, he was in very close touch with all gas and water undertakings—the arrangement between the partners being such that he had control of this portion of the business. The funeral took place at the Eastbourne Cemetery on Saturday.

GAS STOCK AND SHARE MARKET.

(For Stock and Share List, see p. 510.)

A WEEK full of important events closely touching the monetary world! American elections, the failure of the Conference, labour troubles, runs on banks, and a big Government issue, form a remarkable array of factors. In the turmoil, Consols have been a great sufferer. After marking 80 on Wednesday, they dropped to $78\frac{3}{4}$ on Friday. The opening was quiet but unruffled; and the day developed some good points. Many government issues were bought, and Consols advanced $\frac{1}{4}$. Rails were dullish; but other leading lines were strong. Tuesday was intent on the settlement, and fresh business was rather inanimate. But high-class issues were in demand. Consols were done at higher figures, though the nominal quotation was unchanged. Wednesday was agitated by various influences—political, industrial, and monetary. Consols began well, but closed $\frac{1}{8}$ lower. Rails were rather better. Americans see-sawed over the elections; but the Foreign Market was firm. On Thursday, the strong position of Government issues was seriously assailed by the attractive New Zealand Loan; and Consols receded $\frac{1}{4}$. Rails came in for some support by buyers. On Friday, general depression was caused by the failure of the Conference. Government issues of all sorts were put down at once—Consols losing $\frac{3}{8}$ for money and $\frac{1}{4}$ for the account. Everything else was weaker, more or less, except Americans. Nothing came to cheer Saturday; and, moreover, the settlement did not appear to have gone through quite smoothly. The general tone was weak; but Consols remained unchanged. In the Money Market, there was tightness in view of a short supply, and discount rates were stiffer. Business in the Gas Market was more active; some issues being more than usually dealt in. The tendency was quite favourable; movements, though slight, being in the upward direction. In Gaslight and Coke issues, the ordinary improved half-a-point, with transactions ranging between $104\frac{3}{4}$ and $105\frac{3}{4}$. The secured issues were unchanged. The maximum was done at $87\frac{1}{2}$ to $88\frac{1}{2}$, the preference at 103 to $104\frac{3}{4}$, and the debenture at $80\frac{1}{2}$. South Metropolitan was very firm; all dealings being within the limits of $121\frac{1}{2}$ and $122\frac{1}{2}$. The debenture marked 81. Nothing was done in Commercials. Among the Suburban and Provincial group, Alliance and Dublin changed hands at $88\frac{1}{8}$ and $89\frac{1}{2}$, Brentford new at $185\frac{1}{2}$ and 186 (a rise of 1), British at $44\frac{1}{2}$, and South Suburban at $121\frac{3}{4}$. Brighton ordinary advanced 1. In the Continental companies, business was more than usually plentiful. Imperial marked from 189 to $189\frac{3}{4}$ *cum div.*, and from $184\frac{1}{2}$ to $185\frac{1}{4}$ *ex div.* (or a rise of $\frac{1}{2}$). Union was done at from 85 to $91\frac{1}{2}$, ditto preference at 138, European fully-paid at from $23\frac{15}{16}$ to $24\frac{1}{8}$, ditto part-paid at $17\frac{15}{16}$ and $18\frac{1}{16}$, and Malta at $4\frac{5}{8}$. Among the undertakings of the remoter world, Primitiva was dealt in at $7\frac{9}{32}$ to $7\frac{7}{16}$, ditto preference at $5\frac{3}{16}$ to $5\frac{5}{16}$, San Paulo at $15\frac{1}{8}$, and Melbourne $4\frac{1}{2}$ per cent. at 100 and $100\frac{1}{4}$.

ELECTRICITY SUPPLY MEMORANDA.

Depressed Spirits—Fear and Tribulation—Unremunerative Capital Expenditure—Cramb on Meat-Choppers—The Workman and His Light—Metallic Filaments and Price per Unit.

THE outdoor lighting number of the "Electrical Times," upon which comment was made in our issue for Oct. 25 (p. 250), seems to have fallen very flat. No one is heard speaking of it; and it is not being quoted as an authoritative pronouncement on any point. It was, as a matter of fact, like the street vendor's views of the Lord Mayor's Show, all too highly coloured and exaggerated. We rather think that electrical engineers are not in the habit of taking the "Electrical Times" very seriously. But there have been traces of gravity just lately in certain of "Meteor's" paragraphs when dealing with the question of street lighting. Bounce and pretence cannot survive long in face of actualities; and the new street-lighting effects in London by means of high and low pressure inverted gas-lamps are evidently toning down a little the volatile writer of the leader notes in our electrical contemporary. At length, and not any too soon, he recognizes that the new gas-lamps in London streets have intensified the infirmities of the bulk of the street lighting by electricity, though he grudgingly makes the acknowledgment in the words: "The new gas lighting in Victoria Street, with all its faults, is much better than arc lamp effects of twenty years ago." The sneer contained in the words "with all its faults" provides, as it were, a little rift through which sight is allowed of the vindictiveness and irritability that the present position of affairs has provoked in the electrical camp. There is, in truth, genuine fright. "Now that the battle has waxed fast and furious, can the supply authorities," asks our friend, "afford such a heavy loss in prestige." A "heavy loss in prestige!" Few words those, with much meaning attached. "Meteor" urges those authorities without loss of time to tear down the antiquities, and put the latest of flame arc lamps in their place. Nothing short of this drastic measure will do. The time has passed for keeping in use electric lamps whose low efficiency and whose high contributions to the exchequers of the supply authorities stand at the opposite poles. It has indeed more than passed; and gas has shown it to be so.

By the way, has "Meteor" inspected the lighting from the centrally suspended high-pressure inverted gas-lamps in Cannon Street, and compared the brilliance of the lighting with the (in contrast) subdued performance of the centrally hung flame arc lamps? If not, he should do so. He might also spend an interesting few minutes inspecting some new lamp erections at the end of Parliament Street, by the legislative establishment of the nation.

Into such a nervous condition has our esteemed friend fallen that he has been writing at large upon the Gower Street experiment, which is to help the Holborn Borough Council to decide upon which of the illuminants, electricity or gas, is to occupy their streets in future—the Gaslight and Coke Company being handicapped by their terms being known by their competitors before the trial takes place. One might have supposed there had been experiment enough in London. But perhaps it is natural that the Holborn Council, in the spirit of independence that has animated them through this business, should like a little trial on their own account; and this "Meteor" calls "An Exciting Contest." We looked upon the Westminster contest as more exciting than this; the Holborn contract being only one of a number of borough contracts that have fallen due this year for settlement, and the majority of which has, through the inverted gas-burner, been again netted by the Gaslight Company. But "Metecr" wants to dictate the terms of the "exciting" Holborn contest; and it is quite clear that he reflects in what he writes the uneasiness of our electrical friends at submitting the trial street-lamps to photometrical arbitration. There is something that is at once bland, saucy, and distrustful about "Meteor's" sentence: "We are sure that the Holborn authorities will now have every wish to dissociate themselves from the old basis of photometry." His peace of mind is apparently very much disturbed by the photometer. Here is another instance: "The illuminometer method has its drawbacks. In principle, the photometer may be preferable; but, in a street-lighting contest, the conditions are very different from those of the laboratory." Still further uneasiness is reflected in the expression of the impious hope that "the testing and specification will not be allowed to rest upon the candle power at certain angles, for such an arrangement often happens to be favourable to one competitor." This objection to the photometer (how often have Mr. Bradley's tests of the older type lamps been quoted?) was not always so pronounced on the part of electricians as it is to-day, when the constant steady light of inverted gas-lamps is seen in London highways and byways. But we cannot reconcile the strong objection to the photometer that "Meteor" now declares with the statement in the recent special issue of his paper, in the article dealing with photometers: "It would be incompatible with the completeness with which we deal with the question of street lighting, if we omitted mention of the photometer—a device which we anticipate that every street lighting authority will call to its aid in settling questions pertaining to the efficient illumination of streets." What has produced this quick change of front? Perhaps the robust faith of the Gaslight and Coke Company in consenting to a photometrical test of illumination (with a stiff penalty for default) has had rather a nerve-racking effect in certain quarters. But curious it is that the recent outdoor lighting number of his paper has not had a more inspiriting effect upon "Meteor." If it has failed with him, then what about other people? However, in the hour of electrical tribulation, we will be as merciful as business considerations will allow.

It has often been noticed in the papers devoted to the electrical industry that commercial ability is not editorially regarded as a striking or general characteristic of the section of the *genus homo* who occupy official positions in connection with electricity supply undertakings. Much as it goes against the benevolent feelings entertained towards our much-vexed electrical friends, we are at times driven to the conclusion that, in this matter, there is some truth in what the electrical papers say. There is one failing in particular that some electrical engineers have strongly developed, and that is in proposing time after time expenditure on cable extensions that must obviously be unremunerative; and they excuse themselves with the thought that "it is only a little bit, and will not much matter." But these little bits have a tendency to grow; and after a time they may represent anything but a negligible amount of capital. We know of a case where an expenditure of some £300 was incurred for cable to supply a motor which only runs intermittently, at a price per unit represented by a fraction of a penny, lying between 0·5d. and 0·75d. The income in this case does not provide the capital charges fairly attributable to this particular service. Hastings and many other towns have had similar experiences as to unremunerative cable expenditure; but the experience does not act as a deterrent to the propensity for increasing the amount of such expenditure. Take Hastings. There is the famous Clive Vale extension, over which capital was spent, and after a period of two or three years, the connections do not number more than half-a-dozen. But the lesson has failed to have any effect in evoking a greater exercise of care. At the last meeting of the Council, a proposal was passed for spending about £100 in supplying a single consumer; and it was suggested that two or three street lamps might be picked up along the line of this new piece of cable. It requires a good householder whose custom will pay all the expenses incidental to the generation and supply of the current, and the charges involved by a special outlay for cable of £100 of capital on his account. But what matters? The department wants to oblige; and it is such an easy matter to blink at a little supplement to the unremunerative capital. It is, however, a singular way of doing business; but it is, unfortunately for the ratepayers, the electrical way. Perhaps the Local Government Board will make a note of these lapses from sane commercial procedure when there is an inquiry shortly into a proposed application for £2000 odd for cable extensions as required—required by the Department.

Mr. Alex. C. Cramb, the Manager of the Electricity Department of the Croydon Corporation, has been dilating on the fascinating subject of meat-choppers, and has come a cropper at the hands of, we take it, a firm of butchers—Messrs. Rolfe and Taylor—who exercise intelligence, decline to take all Mr. Cramb's opinions at the valuation he himself places on them, and who evidently are of opinion that municipal trading, carried to the length that the Electricity Department carries it in the borough, is not altogether of advantage to the tradesmen ratepayers. We know that from the smallest causes, big issues sometimes spring. The trouble in this instance, is as indicated above all over meat-choppers. Mr. Cramb has written a letter to certain local butchers in the town that seems to suggest that he would, given the opportunity, have the effrontery to try to teach his grandmother how to suck eggs. The letter to the butchers insinuates that Mr. Cramb believes he knows a great deal better than the butchers how to manage their business in the most profitable way. His advice is that all that is necessary is to adopt an electric meat-chopper which would save the butchers' time, increase the ground meat sales, increase the consumers' confidence—in short, the installation of the electric chopper, in addition to the electric light, "makes an ideal business proposition above criticism." Further, this wonderful business-boosting machine, can be fitted with a bone-grinder, and "in view of the importance now attached to ground-green bone as a chicken food," in Mr. Cramb's mature butchery judgment, "it will be found a sound investment." Mr. Cramb says "will be;" so that there can be no question about it. On receiving this informative communication, Messrs. Rolfe and Taylor had some hesitation in accepting Mr. Cramb's representations; and, in addition, they wanted to know what the Croydon Borough Electrical Engineer was doing touting for custom for a meat-chopper made by an American firm, following this up with the suggestion that the American firm might come to Croydon, open a showroom, so contribute to the rates the same as other tradesmen, and relieve the Borough Electrical Engineer from canvassing on their behalf. It is rather an ugly complexion that the firm manage, in a few terse sentences, to put upon this touting by Mr. Cramb, a Corporation servant, for the placing of mechanical meat-choppers. But the Borough Electrical Engineer lost an opportunity by, in the first instance, ignoring Messrs. Rolfe and Taylor's letter; and his neglect caused them annoyance. A reminder that the letter had not received the courtesy of even an acknowledgment brought from Mr. Cramb the curt reply that both letters had been received, and had been duly filed. This is rather a high-handed proceeding; and does not show the diplomatic and conciliatory method that should be cultivated by a municipal officer when any ratepayers address an inquiry to him. But the larger question is as to municipal touting for orders for a machine not made in this country, but which, if required, can be obtained through the agency of one of the local traders. It is stated in a local paper that Mr. Cramb's circular letter was sent out indiscriminately, and caused considerable surprise to the recipients. The publication of the Engineer's method of dealing with correspondents who do not see eye to eye with him, has no doubt had the same effect.

There has been an undue amount of publicity given to what is termed the success of a scheme at Eccles for the electric lighting of workmen's dwellings; but when the details of the scheme are known and considered, gas suppliers will see that they need not quake through any alarm that electricity has at length been proved to be the poor man's light. The experiment has been carried out in a block of twelve workmen's dwellings erected by the Health Committee of the Corporation; and we can imagine that the occupants of these dwellings would take very good care, being under the control and observation of the Health Committee, not to infringe in any way the conditions laid down, particularly with the threat of a prosecution hanging over them if—poor souls—they use any other lamps than those supplied by the Borough Electrical Engineer, remove any lamp and use it in some other room, or replace a lamp by one of their own, or interfere with, or remove or replace, any fittings without the written permission of his highness the Electrical Engineer. Of course, these are essential conditions in a scheme in which a meter is not used for each consumer. But a prosecution for any such offence! Then these poor souls for the twelvemonth of the trial were condemned to (these were specially good houses we should imagine for workmen's dwellings) a 12-candle power light in entrance hall and scullery, a 32-candle power one in parlour and kitchen, in one bedroom a 16-candle power light, and in each of two other bedrooms and the bathroom one 12-candle power light. Fancy the occupants of rooms so lighted reading or doing needle work! Among several agreements these poor folks entered into was one that, when rooms were not being used, the electric light must be switched off, and that no lamps were to be left burning after tenants had retired to bed at night or during the daytime. The charge was 6d. per week, in addition to which the lamp renewals were priced out at 2s. 9d. each for 32-candle power lamps and 2s. 6d. each for 16 and 12 candle power ones. Cottagers would not want many of these extra charges in a year to make them "sit up." But it is reported that only nine new lamps were required in these dwellings during the whole twelve months. These

were especially good tenants—for aught we know employees of the Health Committee. The first cost of wiring, fittings, lamps, and auto-transformer amounted to £61 10s. The aggregate consumption in the twelve months, by these tenants careful not to incur the displeasure of the Health Committee—some of the tenants probably had the convenience of more hours of lighting than others—amounted to 1205 units; and the Health Committee have been charged for these 3·106d. per unit, which works out to the sum of exactly the year's income at 6d. per week from the twelve houses, with nothing over for capital charges and depreciation. It is proposed that the landlords at Eccles should adopt the scheme, wire their cottages, and afford the same facilities to their tenants. We fancy that we can see the office of the Eccles Electricity Department thronged by landlords eager to enter into the speculation. While on this subject, can anyone give any information—perhaps Mr. Charles Carpenter can oblige—as to what has become of that philanthropic company that was started in South London for the propagation of electric lighting among the enlightened workers there?

The question of altering the price of current to consumers in view of the use of metallic filament lamps has been again to the fore through certain supply authorities having adopted this expedient for checking the fall in the lighting revenue. The Legal Correspondent of the "Electrical Review" has been discussing the legal aspect of the question of the right to alter the price of current; but, in the result, he has only emphasized the doubt that exists as to the right of differentiating in the matter of charge between consumers who employ metallic filaments and those who continue the use of the old carbon filaments. Electricity suppliers who boast of the economy of electric lighting ought to be ashamed of themselves for proposing to show any undue preference to the adherents to carbon filaments, both on moral and legal grounds; on the latter because they are commanded by the Electric Lighting Act of 1882, not to, under like circumstances, show "any undue preference to any local authority, company, or person." We cannot imagine that it was contemplated by the Legislature in 1882 that the voluntary use of a different lamp by a consumer would constitute a "circumstance" entitling them to the right of supplying at a different rate. Another obstacle is that the Act expressly provides that the undertakers are not entitled to prescribe any special form of lamp or burner to be used by any consumer, or in any way control, or interfere with, the manner in which the electricity supplied to them is used. In effect the undertakers would be exercising some control and interference by making the metallic filament lamp user pay more per unit than the carbon filament lamp user. A question might also be raised as to whether a supply authority have the right to charge a price to a shopkeeper for outside arc lamps different from that charged to a neighbour who prefers lighting his shop window internally by metallic filaments. We will not follow the Legal Correspondent of our contemporary through the law relating to charges; but on the point to which we have referred, he says: "Upon the whole, it is submitted that the undertakers may have alternate prices. The consumer who uses the modern form of lamp gets the same amount of light [the Act does not say anything about the charge per unit of light] for the same price. In such circumstances, he could not allege that he was unfairly treated." But the gentleman of the long robe does not say—and this is particularly the point on which his readers would like to have his opinion—whether the consumer could not say that he was illegally treated. We would rather be on the side of the consumer when it came to the legality of this matter, and likewise if the common-sense of it was under consideration.

MR. ALEXANDER SIEMENS ON PROGRESS.

At the Opening Meeting for this session of the Institution of Civil Engineers the President—Mr. Alexander Siemens—delivered an address devoted mainly to an exposition of the part played by engineering in bringing about the present state of civilization. The following are some extracts from the portions of the address bearing specially upon this subject.

In order rightly to appreciate the share taken by the engineering profession in bringing about the present state of civilization, a comparison should be made between the conditions prevailing (say) in the Greek States during the Fifth and Fourth Century before Christ and those existing in the Twentieth Century. The history of knowledge from the prosperous period of Greece down to the present time showed that, whether in literature, in art, or in philosophy, we could not boast of being greatly superior to the ancients; but so far as engineering problems were concerned, we had enormously advanced, thanks to the practical application of scientific theories. Comparing generally the conditions of life then and now, the difference might be summed up by claiming that our progress was due principally to the improvement of means of communication and the saving of manual labour by the introduction of mechanical power. These main features had caused a general lowering of the cost of "obtainables." Both of these features characterizing modern civilization were the outcome of the work of the engineering profession; and it might be claimed in addition that progress had by no means ceased.

In attempting to recognize true progress in the material conditions under which we are living, it was not unreasonable to expect that any further advance would be made on the same lines as those differentiating our present civilization from that of the ancients, and that "lowering the cost of obtainables," based on improvement of communications and upon the saving of manual labour, would furnish a trustworthy test as to whether a change suggested to be made in our material surroundings was worth adopting, or was merely an alternative without any prospect of being generally accepted. Everybody readily agreed that improving the means of communication was a desirable form of progress, and that any innovation which had this result had come to stay. But, curiously enough, the consequences of improved communication—implying that people and merchandise could reach distant parts in shorter time than before, and that information could be imparted to most parts of the earth almost instantaneously—were not yet fully appreciated; and the saving in manual labour was still regarded with suspicion by those most concerned. The cry of the workman ever since machinery was introduced had been that displacing manual labour by mechanical power meant diminished opportunity of employment for him; and even nowadays, when the fallacy of this argument had been exposed over and over again, the leaders of the workmen strenuously opposed improvements in this direction as being inimical to their interests.

Coupled with this anomalous attitude regarding machinery was another fallacy, equally difficult to eradicate, which was indicated by what was usually called "restriction of output." This sentiment had its origin in a desire to remedy unemployment; and its promoters always argued that, in order to maintain our present mode of living, a certain amount of work had to be performed daily. If, therefore, each man performed as little work as possible for "living wages," more people must be employed, and workers would have enough to maintain themselves comfortably. The weak point of this view lay in the assumption that the work really necessary to be carried out daily was enough to give employment all round; and the supposed remedy failed because it increased the cost of production. Enhanced cost meant diminished demand, and consequently decrease of sale; but if the sale fell off, producers had to be dismissed. The consequence of restriction of output was therefore restriction of employment—the very opposite effect of what was intended by its advocates. Conversely, it might be argued that cheapening the necessaries of life enabled the consumer to spend more money on luxuries, if by this expression was designated all that was not absolutely necessary for keeping body and soul together. From these considerations, it followed that increase of employment could be effected only by increasing the demand for luxuries; and this could result only from the lowering of the cost of obtainables, indicating by this expression the necessaries of life as well as its luxuries.

Bearing in mind that the distinguishing features of modern civilization—viz., the saving of time, of exertion, and therefore of money—were the outcome of engineering science, it would be conceded without further argument that "lowering of cost" should be the guiding principle of all engineering design; and by accepting this we admitted that successful engineering must be based not only on technical knowledge, but on the proper understanding of economic laws. The extent of the influence of commercial considerations had steadily increased since the middle of last century, owing principally to the great improvement in the means of communication, which, so far as technical knowledge was concerned, placed engineers of all countries on an equal footing, and permitted unlimited competition between manufacturers wherever their works might be situated. Every effort should be made by the designing engineer to facilitate economy of manufacture.

Among the new Mayors, we notice the following who are associated with gas or water supply: Mr. E. Finn, who has filled the position of Mayor of Lydd on twenty-eight occasions and for twenty years in succession, was formerly Chairman of the Lydd Gas Company; Mr. S. R. Groom, the Mayor of Harwich, is a Director of the Gas Company; Alderman F. S. Phillips, the Mayor of Salford, is Chairman of the Gas Committee; Mr. H. W. Sadd, the Mayor of Maldon (Essex), is Chairman of the Water Committee of the Corporation; Sir Samuel Sadler, the Mayor of Middlesbrough for the third time, is well known to "Journal" readers as the head of an important firm of chemical manufacturers, and also as a member and Past-President of the North of England Gas Managers' Association; Mr. H. K. Stephenson, the Lord Mayor of Sheffield, is a Director of the Gas Company; Sir W. H. Stephenson, the re-elected Lord Mayor of Newcastle-on-Tyne, is Chairman of the Newcastle Gas Company; and Alderman T. A. Rising, who has for the second time been elected Mayor of Great Yarmouth, is Deputy-Chairman of the Gas Company and Secretary of the Water Company. In addition to the foregoing, we may note that Alderman G. S. Elliott, who is for the fifth time Mayor of Islington, is Vice-Chairman of the Metropolitan Water Board; Mr. J. U. Fulford, the Mayor of Bideford, is Chairman of the Water Committee of the Corporation; the Marquis of Londonderry, the Mayor of Durham, is head of the Londonderry Collieries; Mr. C. A. Head, the Mayor of Thornaby-on-Tees, established, in association with his brother, the firm of Messrs. Head, Wrightson, and Co., Limited, Stockton-on-Tees; and Sir Benjamin Scott, the Mayor of Carlisle, has been closely identified with the gas and water supply of the city.

WORK OF THE GAS HEATING RESEARCH COMMITTEE.

Conference at the Leeds University.

The members of the Gas Heating Research Committee of the Institution of Gas Engineers, being of opinion that many connected with the industry would like to take part in a further discussion of the work which has been carried out in the Fuel Department of the University of Leeds during the past two years, arranged for a conference to be held last Wednesday afternoon in the University buildings. It had been announced that Mr. E. W. Smith, the Research Chemist, would give a summary of the work done and a short account of the questions involved; an invitation being extended to gentlemen representing gas undertakings and gas-stove manufacturers to be present on the occasion. There was not a very large attendance at the conference—only about thirty in all being present, including Professor Arthur Smithells, the Chairman of the Committee; Professors Bone and Cohen, the University's representatives on the Committee; Mr. J. H. Brearley, of Longwood, one of the representatives of the Institution of Gas Engineers on the Committee; and the principals of a number of firms engaged in the production of gas appliances.

Professor Smithells, in opening the proceedings, extended to all present a cordial welcome on behalf of the Committee and the University, and expressed the hope that at the conclusion of the meeting they would feel that their visit had not been in vain. The reason for calling them together was to afford them an opportunity of discussing the work of the Committee more fully than was possible at the annual meetings of the Institution of Gas Engineers; and the Committee had convened the meeting quite independently of Mr. Smith's movements—being of opinion that a discussion of this kind must be fruitful. Whether or not it was fruitful depended, of course, upon how far those present were willing to discuss the subject, and what Mr. Smith had been working upon. He (Professor Smithells) recognized that there were certain difficulties in the way of discussion; but he hoped they would not be insuperable. By way of starting the discussion, Mr. Smith would give the meeting a brief account of the work that had been done and the experiments carried out. Of course, a good deal of work had been done by Mr. Smith since the Committee presented their last report to the Institution; and this would form the subject of a supplementary report to be submitted next year. Those present were no doubt aware that Mr. Smith was leaving the University for a more important appointment in Birmingham, and he was sure they would understand that this would mean a very great loss to the work of the Committee, so much so that they had recommended to the Council of the Institution that for the time being research work should be suspended. The action of the Council in regard to this would doubtless be communicated to the Press through the official channel in the ordinary way. In the presence of Mr. Smith, he would not attempt to appraise the work done by that gentleman; but he believed he was right in saying it was highly appreciated by all connected with the industry. With these introductory remarks, he called upon Mr. Smith to address the meeting.

MR. SMITH'S ADDRESS.

Mr. E. W. Smith said he had not the time at his disposal to go in detail through the reports of the Committee; but he proposed to consider the gas-fire, part by part, referring to the results of his experiments, and giving the meeting the results of his own observations and experience. In dealing with the gas-fire from a seller's point of view, he took it there were three separate matters to be considered and kept in mind. First, there was the appearance of the fire; next the cost, including maintenance; and then, thirdly, the efficiency of the fire. He would leave the question of appearance, as well as that of cost, with one remark, not because these were of less importance than the other, but because the manufacturers could probably say more on these points than he could.

Radiant Efficiency of the Gas-Fire.

With regard to efficiency, he might point out that at the beginning of his work it was decided to make a special study as to the radiant efficiency of the gas-fire. Though radiant heat had been proved the better heat to encourage in gas-fire work, it was not the total efficiency of the gas-fire, as there was the convected heat from the sides and casing. Personally he had always taken it as a standard that if the temperature of a room was raised from 38° to 60° Fahr. by convected heat, this would be satisfactory; and then they could pile on the radiant heat, so long as by its employment they did not increase the convected heat above 60° Fahr. He was aware that in connection with a gas-fire there was a tendency to consider only radiant heat as being of any value; but it was his personal opinion that the percentages of radiant heat and of convected heat in a room should be taken together as the efficiency of the stove.

Construction of the Gas-Fire.

Passing on to deal with the construction of the gas-fire, Mr. Smith said he believed in the casting being made as plain as possible, consistent, of course, with public taste, for they could not set ideals before the people in these matters. This, however, was a point for the individual manufacturers to consider in the making of the stove. Then came the question as to the extent to which the casing of the fire should be perforated at the top, in order that the air should pass up behind the stove and ensure the fire giving off a larger amount of radiant heat. Considerable difference of opinion existed as to the advisability or otherwise of cooling down the back of the stove. They might take it, however, that the higher the temperature of the back brick, and the lower the loss of heat through it, the greater was the amount of radiation from the front of the stove. Therefore, it was not advisable to cool down the back brick. But this did not preclude them from cooling down the top part of the casting by means of directed air currents. He believed it was quite possible to maintain the temperature of the fire-brick and reduce the heat at the top, so that the air would pass freely and very little of the products (if any) get into the room. There were many ways of stopping the products of combustion from passing into the room. It could be done by the alteration of the outlet of the stove, giving a greater draught, or by a shaped hood that caught the products as they went up. These were points, however, which he did not want to labour, as they could be brought up for discussion later.

The Fire-Brick Back.

As to the fire-brick back, very little attention had been paid to this until quite recently. The material should be as light as possible; and it should be baked at a mean temperature, the reason for which was obvious. As far as practicable, the material at the front of the fuel should have a high heat conductivity, and that at the back a low one, in order that the heat radiated from the back striking the front should pass through the latter as easily as possible. How far this depended upon the thickness, composition, porosity, and shape was a matter for special experiment. There was no doubt, however, that the conductivity of the baked fire-brick did depend upon its thickness, porosity, and shape or form. It had been demonstrated by practical experiments that the lower the temperature at which the fire-brick was baked, the lower the conductivity. Another thing that had to be studied was the formation of the front of the brick, so that it might fit the so-called "fuel;" and the question of "fuel" brought him to the subject of surface combustion. To what extent could they get combustion of the gas taking place actually in contact with the surface of the fuel fire-clay, or of the fire-brick, or actually in the pores of the fire-brick itself? Anyhow, it was clear that the fire-brick at the back should be made to fit the "fuels," or the "fuels" should be made to fit the brick at the back. Then it was essential for the flame to be properly fitted to the "fuels" and brick, so as to get the best results. Many of those present had no doubt proved this by experiments. Having illustrated by diagrams on the blackboard this part of his subject, he said that, for his own part, he thought the fire-brick back should be very similar in shape to the new form of coal-grate brick, sloping out towards the front at the top. A double purpose was served by this. Not only would it cause the products of combustion to stick to the fire-brick, but it would cause a good draught. They would also have a certain amount of convected heat from it; and it would reflect radiant heat, especially if widened to send the heat out into the room, instead of going up into the framework.

"Fuels" and Shape of Flame.

Turning to the subject of "fuels," the speaker said the shape of the "fuel" depended absolutely on the shape of the flame. They must decide either the shape of the flame or that of the "fuel." When they had settled the shape of the "fuel," or of the flame, one must conform to the other. There was a tendency at present to fall away from this, and to arrange the burners in such a way that the flame would be not only inside the "fuel" but outside it. It might, however, be taken as a general principle that it was wise, once they had settled the shape of the flame, to adapt the "fuel" to it. The inner surface of the fuel should be in close contact with the whole of the outer cone of the flame. Interference with the flame or with combustion did not occur when they had the "fuel" in contact with the outer cone of the flame. It was only when they interfered with the inner part of the flame that incomplete combustion took place and gave off a smell. There had been a great advance made in this fitting of the "fuel" to the flame; and he thought more work in this direction would be beneficial. He was quite certain it would repay anyone to deal further with the subject of the shape of the flame, and ascertain to what extent it was affected by the shape of the "fuel" and the composition of the gas. As they knew, the flame from hydrogen was a long, thin one; and thus a "fuel" suitable for a hydrogen flame would be absolutely useless with the flame of Mond gas. The shape of the flame therefore depended upon the composition of the gas to be used. In their last report, the Research Committee showed that the radiant efficiency depended absolutely on the shape of the flame, and, of course, the calorific value of the gas. It was true the latter might vary to some extent without affecting the radiant efficiency of the fire; but if the shape of the flame was varied, in any given type of stove, then the radiant efficiency would be decreased. He was

of opinion that if they had a "fuel" which tapered to the top, the back of the fuel should almost be made up, leaving just sufficient space for air to enter, and that the front of the fuel should be open and irregular. The last point was not his idea of what should be; but the public would have something that conformed as near as possible to the ordinary coal-fire in appearance. Then as to the "fuels" used, they should be as light as possible, and be baked at a mean temperature. They should not be brittle, not soft or hard, but between the two. The reason for this was obvious. It was necessary they should have low conductivity at the back, and high conductivity in front, in order that the radiant heat from the back striking the front should pass through as quickly and with as little obstruction as practicable. The "fuels," like the back, should be as porous as possible on the surface. As to the reason for this, he could not offer a suggestion; but it was evident, in looking at a fire, that the rougher the surface of the "fuel" the better its radiant efficiency. A further point in connection with the "fuels" was that he held the opinion that it was wiser to have the upper 1¼ or 2 inches of the "fuel" dark than incandescent right to the top. They knew that the products of combustion always left the top of the "fuel" at a higher temperature than the bottom—the products would leave at a temperature of 950° C. But if they constructed the "fuel" so as to be radiant up to about two-thirds of the way, then the top part would take up part of the heat of the products of combustion. Not only this, but the top part would help to keep warm the fuel below; and they would have a larger surface of fuel radiant.

The Burner Question.

Passing on to deal with the question of burners, the speaker said he had just finished some work on this part of the subject, and he had no doubt it would be published in the course of a few weeks, as soon as the Committee had seen it. On general grounds, quite apart from what had been done, he said that in the design of the burner the endeavour should be made to get an even mixture of gas and air, and even sizes of flame. It was a fact that some burners required more air than others with the same consumption of gas; and therefore it was not so much the amount of air that was pulled in at the burner. If they took a burner with a large number of small holes, it would be found that it required less air than one having larger holes, and this with the same consumption of gas. The explanation was that in the former case the smaller flames presented a larger percentage of surface to the atmosphere, and consequently less primary air was required at the burner. The burner should be noiseless; but he confessed that he had found it impossible to get a burner that was absolutely noiseless. He thought they would find that the longer the tube was from the nozzle, the greater was the humming noise, and *vice versa*.

Temporary Cessation of the Work.

This was all he thought he need say about the work done; but if any one present desired to put questions, he would answer them, if he could. He might add, in conclusion, that it had been decided that the Research Committee should be dissolved and its work discontinued for the present. But it should not be assumed that they were of opinion there was nothing further that required doing. Personally, he was of opinion that the research work on gas-stoves was only just commencing; but any further work would require much greater facilities than could be possibly obtained in a University. Further work, he suggested, might be undertaken by the makers themselves. They were showing a desire to continue and extend the work that had been commenced at the Leeds University by engaging well-trained men. He considered this would be found to be thoroughly worth while. They should, however, not regard the engagement of such men as a fad or an advertisement, but give them the opportunity of carrying on sustained research of a really advanced character. Many good research men might be found spending the whole of their time either doing routine analyses, or continually at the beck and call of the heads of departments in attempts to solve the hundred-and-one little problems that cropped up in the course of a day in the works. A man of this kind was extremely useful—he was a works chemist, but not necessarily a research chemist.

Discussion.

Professor Smithells, in announcing that the discussion was open, said it must be understood that Mr. Smith had been expressing his own views and opinions.

Mr. H. M. Thornton (London) said he thought that they were much indebted to the University Authorities for allowing them to take part in this important meeting; and, if he might be allowed to say so, it was a fitting conclusion to the splendid work which Mr. Smith had done for the industry. They were greatly obliged to him for the way in which he had carried out his research work, and also for the manner in which he had put the results of his labours before them. The different points dealt with had been placed before them in a very clear way; and they, as gas-stove makers, would miss Mr. Smith very much. The research work carried on by him generally had afforded them the opportunity of seeing whether or not the gas-stove makers had been working on the right lines. He did not propose to go over the whole ground covered by Mr. Smith in the course of his address. This was not necessary. He would like to say, however, that most of the points Mr. Smith had raised had been already very largely dealt with by the manufacturers of gas fires and other appliances. There were, of course, points of detail well worthy of further experiments; and he thought most of them were now engaged in conducting these experiments, and in research work generally in this direction. There were one or two points mentioned by Mr. Smith which he thought gas-stove manufacturers were dealing with. There was the question of the shape of the flame. Manufacturers had, of course, been experimenting very largely in this direction. He was speaking for his own Company; but they were not alone in this respect, and he believed there was room for further experiment. Undoubtedly, the shape of the flame must guide them in the shape of the "fuel." The two were so closely connected that the shape of the "fuel" should be in accordance with the shape of the flame; and this was the case with his firm. The other point he wished to deal with was that of finality. What manufacturers did want was to reach finality, if it was at all possible. They wished to know, for instance, how much convected heat should be employed in connection with gas-fires. He was glad that the opinion of Mr. Smith—and he thought it was the opinion held by a great many men—was that a certain percentage of convected heat was not only desirable in the attaining of the best results, but was a distinct advantage in connection with gas-fires as a whole. Another important matter—and one they felt very strongly upon—was that they desired to see some definite standard of testing gas-fires adopted by gas undertakings, so that they might know under what conditions their apparatus was to be tested. At present, they found that in some cases it was tested by certain methods, and in other cases by different ones. The consequence was that different results were obtained. He hoped some final solution might be arrived at in this matter; and then they would know in what condition they would have to send out their goods. With reference to the length of fuel to be made incandescent, he was of opinion that they would get a slight gain in efficiency by leaving a part at the top dark. At the same time, he thought they must give attention to appearance, and, if necessary, sacrifice a small percentage of efficiency to obtain it. He was not quite clear as to what they were there for that afternoon. He did not know whether they were to be asked to support a movement for further research on gas-fires, or what. Was there a suggestion that they should support further movement in this direction? He thought they ought to know with more or less certainty what was meant. Apart from this, he desired to express, on behalf of his Company, their grateful thanks to Mr. Smith and the Research Committee of the Institution of Gas Engineers for what had undoubtedly been exhaustive experiments which had been of advantage to the gas industry at large.

Mr. Smith said that whenever a maker quoted efficiency, he should give other details as well. He should give something more than the gas consumption—such as the total superficial area of the heated surface. If it was a 12-inch stove let it be called a 12-inch stove. It might be taken as a fact—and it was raised in their last report—that for every inch increase in the stove they obtained 1 per cent. increase in efficiency. He agreed there should be a standard type and size of fire, and that they should always test against the same size. He explained that he was now engaged in the design of a special absorption radiometer. Various circumstances had prevented him completing it; but he intended to continue until he had done so. He was of opinion that it would turn out all right, and by it he would be able to get a curve of radiant heat all round the hemisphere. In testing fires for radiant efficiency, pressure did not count—it was only the gas consumption and the quality of the flame that counted.

Professor Smithells, answering Mr. Thornton, said that the Research Committee, after the establishment of the Livesey Advisory Committee, which represented the Institution of Gas Engineers, came to the conclusion that their position had become somewhat anomalous. In fact, the Research Committee thought that work of this kind, if it had to be done at all, might be better done under the direction of the Livesey Advisory Committee. Consequently, the Research Committee were recommending their own dissolution. What work would be done in the future, or whether any work similar to this would be done at the University, he could not venture to say. This would be a matter for the Livesey Advisory Committee and the University authorities to consider. When they called this meeting, they did not know that Mr. Smith was leaving—it so happened that the two things coincided. They must understand that they were called there that day, not only to listen to Mr. Smith, but to say anything they liked on the question of research work. If they considered it was important that the research work should be continued, they were perfectly at liberty to say so.

Mr. J. H. Brearley (Longwood) said that Professor Smithells had accurately expressed the views of the Research Committee and the reason they had resolved to recommend its dissolution. He had already expressed his admiration of Mr. Smith's work; but as this was perhaps the last occasion he might have of doing so, he desired again to express his appreciation of his services to the Committee. He would only repeat that in Mr. Smith they had an investigator who had the greatest enthusiasm in his work. Not only this, but he had the highest scientific qualifications to support his enthusiasm in the work he had in hand. He wished him every success and prosperity in his new work at Birmingham. It had not been his (Mr. Brearley's) intention to say much that afternoon on the question of the research work carried out by the Committee; but one or two points had been raised upon which further research would be required. There was, for instance, the question of the shape of the flame. Seeing that they had so many

makers present, he would like to ask whether it had been found that gas-fires that were perfectly satisfactory in one town were anything but satisfactory in another. He should rather doubt they had, because gas supplies varied enormously in their composition. They had heard that afternoon that a "fuel" suitable for a hydrogen flame would not do for a flame containing a large percentage of carbon monoxide. This was the conundrum facing the makers; and they had his sympathy on this point. There had been a great deal of talk as to a standard burner for testing illuminating power. And while he was in complete sympathy with a desire for a standard burner, he thought that a standard for the quality and composition of gas was even more important. With regard to Mr. Smith's suggestion that the top part of the "fuel" should be left dark—the proposal being that one-third at the top should be dark and the remaining two-thirds incandescent—he would like to ask if this would be necessary if makers provided a sloping back brick. The sloping back was intended to intercept certain heat and reflect heat; and he wanted to know if this would not assist in keeping the efficiency of the "fuel" right to the very top. The last point he would like to mention was with regard to the conductivity of the materials put in. They had very little knowledge at present on this point. He believed the Institution had a Research Committee at work on refractory materials and making some experiments as to the conductivity of fire-clays and their composition; but he did not know whether this would help them much. At any rate, that was one matter which required the attention of the Research Committee.

Mr. SMITH said he could not state if the sloping back mentioned by Mr. Brearley would fulfil the conditions of the dark top of the "fuel." At the moment, he did not think it would be sufficient to meet the conditions.

Mr. A. J. FORSHAW (Birmingham) did not believe there was a great deal left for the Committee to do with regard to gas-fires. The Committee, to begin with, had not the facilities for making "fuels" and burners for experimental purposes that the manufacturers had, and except it was in the direction of devising a method or methods for the better testing of gas-fires, he did not know what the Committee could do further. Some of their methods were certainly cumbrous, and improvement was necessary. Mr. Smith had made several suggestions to them that afternoon—for instance, in regard to the use of convected heat from gas-fires. His (Mr. Forshaw's) Company had taken a strong stand on this point—to have as little convected heat as possible; and he might say they had been successful. It would be difficult to maintain the temperature of a room at less than 60° if they kept pouring into it convected heat and radiant heat at the same time. On the question of flame contact, it appeared to him that what they should aim at in gas-fires was to get as much heat out of the gas into the "fuel" as possible, before the gas went up the chimney. Of course, long "fuel" was one way of doing this; and another method was to have a corrugated back. As to the "fuel" fitting the flame, he confirmed what Mr. Smith had said. He had been trying Mond gas in a fire; and it was surprising to find how much gas it took to heat up the fuel. This was simply due to the flame of the Mond gas being thin and attenuated. With reference to the giving off of carbon monoxide, he had tested many appliances, and was satisfied that very little (if any) was given off.

Professor SMITHELLS remarked that the hygienic point ought not to be forgotten; and this was a question that might with advantage be taken up more fully than it had been. Dr. Cohen, who was a member of the Research Committee, had carried out some investigations in this direction; and he asked him to give them the benefit of his experience.

Professor COHEN said that he became interested in gas-fires when he went to Leeds some twenty years ago. It was then he started serious research on the condition of the atmosphere as regarded smoke; and he thought it desirable he should carry out in practice what he preached. Therefore he had three or four gas-fires put in at his house. Shortly after this, he attended a lecture at the University on ventilation; and in the course of the lecture reference was made to gas-fires. The lecturer stated that they gave off carbon monoxide into the room, and were not to be recommended. This statement, naturally, made him (Dr. Cohen) very uncomfortable; and he asked the lecturer if he could give him some reference to an authority for the statement, or whether it was made from his own observations. In reply, he was told by the lecturer that he could not give him a reference to any authority, nor had he made any observations himself. He added, however, that he felt quite sure it was so. Well, of course, this diagnosis might be satisfactory to a medical man and others interested in the matter; but it was not satisfactory to the chemist. He (Dr. Cohen) thought he] should like to carry out investigations of his own; and he applied to Mr. James Wilson, asking to be allowed to make experiments with his gas-stoves. To this Mr. Wilson agreed, and also accepted the stipulation that whatever the result was, he (the Professor) should be at liberty to publish it. The result of a number of tests carried out with the stove was that he failed to detect carbon monoxide gas passing into the room from the fire—in fact, he did not discover any carbon monoxide passing into the flue at all. There were a number of hydrocarbons found in the flue; but, so far as his test went, there was no carbon monoxide. These results were published; and it was his opinion that no carbon monoxide was given off from gas-fires. With reference to Mr. Forshaw's statement that there was nothing more for the Committee to do in regard to gas-fires, he could not agree. He (Dr. Cohen) thought there was still a great deal to be done; and he hoped it would be done. There were certain problems on the subject which required dealing with. One of the most important questions in connection with the efficiency of the gas-fire was the relation between temperature and radiation. It was certain that there was a connection; but they did not know the proportion of the connection. They might get a high temperature, but no proportion in radiation; and it was certain there were a great many uncommon things which connected the two. This was a subject which ought to be scientifically investigated. If the work of research was to be continued, as he hoped it would be, under the supervision of the Livesey Advisory Committee, he thought this problem should receive attention. He was in agreement with Mr. Smith's conclusions in regard to radiant heat and convected heat. He asked why it was that, in the summer time, with no form of artificial heat, people felt comfortable indoors? They had no radiant heat indoors from the sun; and the only logical answer was that the air in the room was warm. It therefore seemed to him that if they could maintain this condition in the winter by means of artificial heat, they would be getting the same conditions as they had in the summer, which would be perfectly healthy and hygienic. He was of opinion that they should have the air in their living-rooms heated to a certain temperature—not too high, so as to cause any feeling of discomfort—before they started their radiant heat. This principle was now being applied most satisfactorily—that was, the fresh air in the room was heated up to a certain temperature and the further heat required was obtained by radiation.

Mr. JAMES WILSON (Leeds) said there was just one point he would like to deal with, which had been raised during the discussion, and that was the testing of gas-fires. It seemed to him there were only two ways of testing them. It must either be in the room or in the chimney; and the question was whether it was easier to carry out the test in the room or in the chimney. A simple method, he thought, might be devised of testing the efficiency of gas-fires by means of the heat found in the chimney, without dealing with the radiant heat. Certainly they needed some simpler method of testing the efficiency of the stove without dealing with the question of radiation.

Mr. A. P. MAIN (London), having paid a tribute to Mr. Smith for the services he had rendered to the Research Committee and the gas industry, expressed the hope that something would be done to continue the work. They were now really only at the beginning of the gas-fire business; and he ventured to remark that nobody could say what the gas-fire would be ten years hence. He was of opinion that they were a long way off reaching finality in this matter. It was of great importance to the gas industry to have a scientific body to go into the question of standardizing some form of testing gas-fires. No one but those who had tried knew of the difficulties they had to contend with in the matter of testing. He did not think it was beyond the powers of the Research Committee to devise some simple method of testing. Professor Smithells had referred to the hygienic aspect of the question; and he (Mr. Main) was quite sure that the University could give them some definite pronouncement on the matter. At Glasgow, an interesting series of lectures on the question of smoke abatement had been arranged, which might be followed with advantage in other centres. He did not think they had been sufficiently alive to the fact that we were at the dawn of a new era—that the time was coming, and coming rapidly, when smoke pollution of the atmosphere would be prohibited by Act of Parliament. This being the case, the question of the provision of smokeless heating appliances was one of the greatest consequence to this country; and for this reason he strongly held that the work of the Research Committee should not be allowed to relax in any way, because he felt they were just at the stage when they needed their advice more than ever.

Mr. J. A. RANSOME (Warrington) much regretted that so few gas engineers were present at the conference that afternoon, and proceeded to say they all knew that the gas-fire sold to the public to-day by the makers was a great improvement on those of a few years ago. These improvements had not been obtained without a lot of work and a good deal of cost; and yet many of their gas engineer friends seemed to think they should have the improved fire at the old figure, or even at a lower one. They seemed to forget that the "fuel" of to-day could not be produced at anything like the cost it was a few years ago. If only gas engineers would recognize the difficulties which had to be overcome and the extra cost entailed, and take more trouble with the fires, when they got them, than they did at present, it would be to the advantage of all concerned. He appealed very strongly that the work of the Research Committee should not be allowed to drop.

This ended the discussion; and those who had been present availed themselves of the invitation extended to them by Professor Bone to inspect the Fuel and Metallurgical Department of the University. Here light refreshments were served.

The Council of the Roads Improvement Association (Incorporated) and a few friends entertained Mr. Rees Jeffreys at dinner at the Trocadero Restaurant, W., some days ago. The function was made the occasion of a presentation by the Association to their guest of a roll-top desk and an arm-chair, as a mark of their appreciation of his valuable services in connection with the movement for the improvement of roads during the last ten years.

SOUTHERN DISTRICT GAS ASSOCIATION.

The General Meeting of the Association was held on Thursday last, at the Hotel Cecil, Strand, W.C. In the absence of the President (Mr. C. Stafford Ellery, of Bath), Mr. H. C. HEAD, of Winchester, occupied the chair. There was an excellent attendance of members.

PRESIDENT'S UNAVOIDABLE ABSENCE.

The CHAIRMAN said, before starting the usual business. he had to announce with regret that the President (Mr. C. Stafford Ellery) was unable to be present that day. He wrote to the Hon. Secretary the previous day, saying that he was having an unfortunate experience with the connections of one of his gasholders; and most probably he would not be able to attend the meeting. A telegram had been received from Mr. Ellery that day, regretting his unavoidable absence, expressing best wishes for the meeting, and thanking the authors of the papers to be read. He (the Chairman) would propose that the Hon. Secretary be instructed to send a letter to the President sympathizing with him in his difficulty, and wishing him a speedy solution of it.

The suggestion received hearty approval.

MINUTES CONFIRMED.

The HON. SECRETARY (Mr. W. E. Price, of Hampton Wick) presented the minutes of the spring and excursion meetings; and they were confirmed.

ELECTION OF OFFICERS.

Mr. J. W. HELPS (Croydon) proposed that Mr. H. C. Head, of Winchester, be elected President of the Association for the coming year. He (Mr. Helps) did not think that anything he could say would tell the members better than they already knew how well fitted for the position Mr. Head was. He had been trained all his working life as an Engineer, he had had considerable experience at Bournemouth, and in his present position at Winchester, and they all knew what good work he had done for the Association. He had read a useful paper; and he had taken a great share in the deliberations of the Committee for many years. He had also devoted himself to the interests of one of the branches of the Association's work—that was, the Commercial Section. He (Mr. Helps) did not think it necessary to say more to commend Mr. Head's name to the members.

Mr. R. BEYNON (Torquay) seconded the motion, which was unanimously carried.

The CHAIRMAN observed that he thanked Mr. Helps very much for the kind manner in which he had proposed his election as President, and the members for the way they had received the proposal. The post of President of the Association was not altogether an easy one to fill. A long line of Past-Presidents had set a high standard, which it would be somewhat difficult to keep up to. But the members might be assured that anything he could do for the benefit of the Association, and to maintain its high standard and traditions, would be done.

Dr. HAROLD G. COLMAN moved that Mr. B. R. Green, of Mitcham, be the Vice-President for the coming year. The name of Green had long been identified with the Southern Association—in the case of the father, and now the son; and the members would agree with him that Mr. Green would occupy the position in a very fit manner. They knew him to be a man of progressive character and moderate views; and they would look forward with great pleasure to having him as their Vice-President.

Mr. A. E. BROADBERRY (Tottenham) seconded the motion, which was heartily carried.

Mr. GREEN, in acknowledging his election, thanked the members sincerely for the honour conferred on him. He could only say that he would do his best to fill the office as the members would wish him to. He began, however, to already feel the weight of responsibility in connection with it. He hoped that Mr. Head would have a successful year as President, and enjoy health and freedom from difficulty during that period, so that he (Mr. Green) would not be placed in the position that the Vice-President had found himself that day.

Mr. W. D. CHILD (Romford) remarked that he had great pleasure in proposing Mr. Price as the Hon. Secretary of the Association. Mr. Price possessed the happy geniality of disposition that specially qualified him to carry on the work of this office. The position had been held in the past by some eminent men; and Mr. Price would not allow the high position to fall back owing to want of any efforts on his part.

The CHAIRMAN seconded the motion, and it was unanimously agreed to.

Mr. PRICE, in his acknowledgment, observed that he should do his best to keep the standard of efficiency in the performance of his work as high as it had been maintained by his eminent predecessors in the office.

Mr. HAROLD W. WOODALL (Bournemouth) moved that Messrs. H. Buckley, Mr. A. E. Broadberry, and Mr. H. O. Carr be elected to fill the vacancies on the Committee.

Mr. S. CARPENTER (Dorking) seconded the motion, which was unanimously carried.

On the proposition of Mr. C. E. BOTLEY (Hastings), seconded by Mr. A. F. BROWNE (Vauxhall), Messrs. J. L. Chapman and A. Dougall were re-appointed Hon. Auditors.

NEW MEMBERS.

The HON. SECRETARY read the names of the candidates for election to membership. They were as follows: Mr. James W. Auchterlonie, of Cambridge; Mr. John Mackay Campbell, of Margate; Mr. Arthur Easton, of Faversham; Mr. William B. Farquhar, of Ilford; Mr. Charles Hulme, of Uxbridge; Mr. Alex. A. Johnston, of Brentford; Mr. George Mead-Robins, of Sutton; Mr. John Mitchell, of Friern Barnet; Mr. Lawrence W. Nuttall, of Gosport; Mr. F. W. Rapkin, of Dartford; Mr. W. Netherway Westlake, of Exeter.

The CHAIRMAN said there were eleven applications for membership, which was a matter on which they ought to congratulate themselves, and their Hon. Secretary for the excellent manner in which he was looking up everybody. The whole strength of an Association such as this rested on its being fully representative of the entire district. He had pleasure in moving their election.

Mr. T. PRICE (Walton-on-Thames) seconded the motion, which was unanimously carried.

INSTITUTION BENEVOLENT FUND.

The CHAIRMAN said the next item on the *agenda* was a statement by the President with regard to the Benevolent Fund of the Institution of Gas Engineers; but he (Mr. Head) had no information as to what Mr. Ellery would have said to them on this subject had he been present. The main point was contained in the circular-letter that Mr. Ellery had addressed to the members regarding new subscribers to the Benevolent Fund. He (Mr. Head) did hope that those members who were not already subscribers to the fund would extend their support to it. He had never had anything to do with the management of the fund, but he was told only the other day that there were three or four cases last year which would have been helped had funds permitted; and these were all deserving cases. He repeated that he hoped those who were not now subscribers would quickly subscribe. Subscriptions as low as 5s. a year were gratefully accepted.

PAPERS READ.

There were three papers read, as follows:

"Sulphate Manufacture for Small Works." By PHILIP G. G. MOON, of Bournemouth.

"District Pressure." By THOMAS PRICE, of Walton-on-Thames.

"High-Pressure Gas-Lighting." By A. E. BROADBERRY, of Tottenham.

The papers are reproduced in other parts of this issue, together with reports of the discussions on the first two. Mr. Broadberry's paper was illustrated by some magnificent lantern views of some of the high-pressure lighting that the Tottenham and Edmonton Company have carried out at the Alexandra Palace and shop lighting in various parts of the district. The paper was not discussed on this occasion; but there is a proposal that Mr. Broadberry should at a future meeting supplement it, and that then the present and supplementary contributions should be discussed together.

At the close of the paper,

The CHAIRMAN said he thought that the members would agree with him that the hour was too late to have a proper discussion of such a magnificent paper. Mr. Broadberry had been unable to let the members have copies of the paper in advance, so that they might prepare themselves for getting more information out of him on a subject that he knew so well, and so much better than most of the members. He (the Chairman) was going to suggest that the discussion might be postponed until next year. It was rather a long time to which to look forward; but Mr. Broadberry said he would then read a little supplementary paper to bring the matter up to date again. By that time, he (the President) hoped many of the members would have had more experience than they had at present of high-pressure lighting, and, so equipped, there should be a fine discussion. In conclusion, he proposed a vote of thanks to the authors of the three papers.

Mr. B. R. GREEN, in seconding the motion, remarked that he was sure they would read Mr. Broadberry's paper with great benefit. It had interested him considerably, more particularly seeing that Mr. Broadberry had given him information which had enabled him to start similar installations in the district of the Mitcham and Wimbledon Company; and the installations had been highly successful. He, for one, would look forward with a great deal of interest to the deferred discussion.

The motion was cordially passed.

This concluded the proceedings; and almost immediately afterwards "high tea" was served.

It was the intention of the Chemical Society earlier in the year to give a banquet in honour of certain Past-Presidents; among them being Professor Odling, F.R.S., Sir William Crookes, F.R.S., and Dr. A. G. Vernon Harcourt, F.R.S. It was postponed on account of the death of King Edward; but it took place at the Savoy Hotel last Friday.

RECENT PROGRESS IN, AND THE PRESENT STATUS OF, GAS LIGHTING.

By F. W. Goodenough.

[Extracts from a Paper Read before the Illuminating Engineering Society, Tuesday, Nov. 8.]

The object of this paper, as I understand it, is to put before those responsible for, or interested in, the illumination of premises or thoroughfares information respecting recent developments and the present possibilities of gas lighting; so that, should that illuminant be selected for any installation, the greatest efficiency may be secured and maintained at the least cost.

This is not the occasion, nor is the platform of the Society the place, for any discussion of the relative costs or merits of rival illuminants. That is a battle which must be, as it is being, fought out in the less peaceful atmosphere of the commercial world; and, while not averse from taking a modest share in the combat when occasion serves, I hope that I shall now and at all times succeed in keeping anything I may say at a meeting of the Society (which stands or falls by its power to avoid commercial as opposed to scientific controversies) free from offence to my good friends who are interested in other illuminants. For this and other reasons, I have reluctantly come to the conclusion that it is only possible to deal with my subject on the most general lines; and this must be my apology for the meagreness, and, I am afraid, the dull and uninteresting character, of my paper, which is confined strictly to general terms.

The Inverted Burner and Shop Lighting.

Consideration of the recent history and the present position of the science of lighting by coal gas necessarily centres itself upon the inverted incandescent burner; whether one is considering the utilization of gas at the ordinary district pressure of (say) 3 inches head of water, or the use of gas under special pressure of (say) 6 inches head of mercury, which is becoming very general, especially of late, for, among other purposes, the exterior lighting of rows of shops. In such cases, the gas at increased pressure is supplied from a common centre and charged for on the basis of estimated consumption for a predetermined number of hours per annum (arrived at from an agreed time-table for lighting and extinguishing), *plus* maintenance charges and working costs. For this co-operative system of lighting, there is undoubtedly a large opening. It will certainly improve the appearance of the streets in which it is adopted, as the striking lack of uniformity in—the enormous difference between—the power and character of the lights employed by the various shops in our streets at the present time detracts very largely from the general effect.

History Repeats Itself.

It is of interest to note that the inversion of the burner has been the means of increasing the light obtained per cubic foot of gas consumed in both of the two distinct eras of gas lighting—the era of the directly luminous and that of the Bunsen, or indirectly-luminous, burner. The inverted burner of the Siemens or Wenham type increased the efficiency of the luminous burner nearly threefold—viz., from 2½-candle power per cubic foot in the ordinary batswing burner, or 3¼-candle power per cubic foot in the argand burner, to 8 or 9 candle power per cubic foot in the Wenham lamp. The result was, of course, due to the heating of the gas and air prior to combustion.

Welsbach's great discovery of the incandescent mantle, with its ultimate efficiency in the supported—or, as it is generally called, the upright—form of from 20 to 40 candle power per cubic foot, according to the pressure used, necessarily eclipsed the inverted luminous burner. But history has repeated itself in this case. The inversion of the incandescent burner has brought about a materially increased efficiency; and the inverted mantle has now eclipsed the fork-supported type. This is due not only to the higher efficiency of the former, but also: (1) To its lending itself to the use of shadowless lamps; (2) to its capability of being used in considerably smaller units of light—from, say, 25-candle power upwards instead of a minimum of 50-candle power; (3) to its consequently lending itself more readily to artistic effect in illumination; and (4) to its further capability of being used in larger units of light—any power up to 4000-candle power in one lamp being obtainable.

High Efficiencies and Light Distribution.

The latest pattern inverted burners supplied with gas at the ordinary district pressure of 3 inches (water-gauge) give an efficiency of 30-candle power per cubic foot consumed; while used with a pressure of about 90 inches water-gauge (equal to about 6½ inches mercury gauge), the inverted burner gives an efficiency of 70-candle power per cubic foot consumed. These higher efficiencies are due to a higher flame temperature being obtained by the pre-heating of the gas and air, which, after admixture, descend to the point of ignition through a tube surrounded by the ascending products of combustion. The figures given are maximum candle powers averaged between the angles of 10° to 40° below the horizontal—that being, in my view, the direction in which it is desirable that maximum illumination should be available to ensure as even a diffusion of light as possible.

With the light emanating from a source of the shape of an inverted mantle, which gives direct rays in every direction except immediately upwards, and which is not obscured in any direction below the horizontal, adequate light is always assured in the immediate vicinity of the burner; and as the greater the distance the light has to travel to reach the object to be illuminated, the greater the initial power of the far-travelling rays must be in order to produce illumination approaching in efficacy to the illumination of objects more nearly under the source of light, it is of importance to the illuminating engineer that the burner he

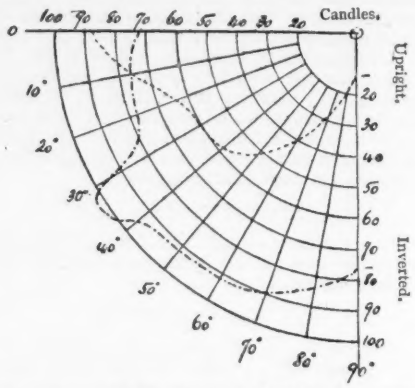


Fig. 1.—Characteristic Curves of Upright and Inverted Low-Pressure Gas-Burners.

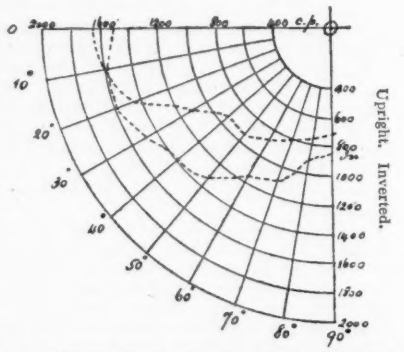


Fig. 2.—Characteristic Curves of Upright and Inverted High-Pressure Gas-Burners.

uses should be capable of doing its best work in the direction in which most light is wanted. At the same time, the light in other useful directions must be proportionately adequate; and that is a valuable characteristic of the inverted mantle. This is illustrated by figs. 1 and 2, showing the characteristic lighting curves that are obtained from inverted burners of both ordinary and high-pressure types, compared with those obtained from burners of the upright pattern.

Light Concentration and Reflectors.

Where greater concentration of light in any particular direction is essential for specific purposes—as, for example, for lighting shop windows from without, or for drawing-boards, machines, compositors' frames, and the like, lighted from above—this can, of course, readily be obtained by means of suitable reflectors. Here, again, the inverted burner possesses advantages over the older type, owing to there being no obstruction whatever of the downward rays. The effect of imposing suitable reflectors for downward lighting is illustrated by figs. 3 and 4.

Street Lighting and Central Suspension.

The advantage of the light from an inverted burner being entirely free from obstruction below the horizontal enables it to be used effectively for street lighting, not only in the column-supported lamp, but also in suspended lamps, whether from brackets as in Fleet Street (high-pressure) and the eastern end of Cheapside (low-pressure) or centrally hung from cross wires as in the eastern end of Cannon Street. The central hanging of gas-lamps from cross wires, the gas being conveyed to the lamps either by flexible metallic tubing or by barrel with flexible joints—enabling the lamps to be drawn to the side of the street, and lowered for purposes of maintenance—is one of the latest adaptations of gas lighting in this country, though it has been adopted in several towns in Germany for some time past. The trial installation of this system at the eastern end of Cannon Street (which is only just in course of completion) will, therefore, be of interest to those who favour the system of lighting streets by crosssuspended-lamps, which I personally, as an illuminating engineer, regard

as radically unsound, and, as a humble citizen, consider an unnecessary aggravation of the already too frequent disfigurement by overhead wires of the, at all times, too restricted amount of sky vouchsafed to our town-tired eyes.

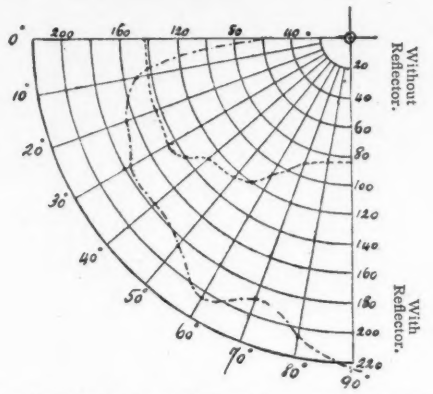


Fig. 3.—Alteration to Curve Obtained from an Inverted Burner by Fitting a Reflector to Concentrate Light on Office Desks.

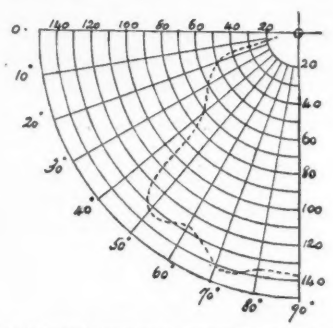


Fig. 4.—Curve Obtained by Use of Pyramid Reflector with Inverted Burner for Giving an Intensified Light on Drawing Table.

Illustrations of Usual Methods of Application.

The application of the inverted burner to the more usual method of street lighting—viz., by column-supported lamps, has recently been illustrated on a considerable scale by the substitution of inverted burner lamps, both low and high pressure, for the older pattern gas-lamps in portions of the City of Westminster. Good examples of the latest high-pressure inverted gas-lamps will be found in Victoria Street (one being conveniently placed opposite the offices of the Society) and in Parliament Square and Whitehall; while as good specimens of street lighting by low-pressure inverted lamps, I might mention Great George Street, Ashley Gardens, Vauxhall Bridge Road, Kensington Road from Knightsbridge to Queen's Gate, Prince Consort Road, St. James's Square, and Carlton House Terrace.

Some photographs (taken at night by the light of the lamps) which I have had reproduced illustrate as well as such photographs can the even diffusion of light obtained.* This is due mainly to the fact that the rays of highest power are those at an angle of 10° to 40° below the horizontal; but partly also to the fact that the shortness of the mantles, and the height (and distance apart) at which the mantles are placed in the lamps, ensure that one mantle does not obscure the light of another in any useful direction.

It is a matter of congratulation to the honest and respectable wayfarer by night that our local authorities are becoming more and more alive to the imperative need for a higher standard of efficiency in street lighting in the Metropolis, which has arisen out of the rapid and ever-increasing growth of fast motor traffic in the streets. At night, motors at a distance must be made clearly visible to pedestrians if the crossing of a street is not to become a matter not only of anxiety but of serious peril. Illuminating engineers who have influence with local authorities may do good service to their fellow-citizens by laying stress upon this point.

Automatic Lighting and Extinguishing.

A further point of interest to mention in connection with recent developments in gas lighting for streets, is the extending use of automatic appliances for the lighting and extinguishing of street lamps. Those of the clock-actuated mechanism type are not well suited to districts where irregular lighting of the lamps is from time to time necessitated by the sudden advent of fog, for which purpose the necessary staff no longer exists if clockwork lighters have been installed. This is a point that needs to be borne in mind by any Metropolitan authority who are considering the adoption of automatic appliances for street-lamp lighting. The objection does not apply to the class of automatic apparatus which is operated by an increase of gas pressure given at the lamp from the gas-works when required, for either lighting or extinguishing. There are several forms of pressure-operated apparatus, some of which are best suited to districts having a simple system of distribution from a single works, but which do not, as other appliances do, meet the peculiar conditions of undertakings having a complex system of distribution from a number of works supplying a common network of mains. The latest form that is being tried in London has the peculiarity of being affected by sudden slight rises in pressure deliberately applied without being operated by gradual increases such as occasionally take place after lighting-up time, due to variations in load on mains that are working to the full capacity. It may be remarked, in passing, that a much closer approximation of the pressure-register line to a constant reading than in former years is one of the modern developments of gas supply.

Automatic methods of lighting and extinguishing can also be readily applied in the case of both low and high pressure gas supplies where all the lamps to be lighted are on a common service. This, of course, applies to either street or internal lighting. In the case of high-pressure installations, the act of starting the compressor will light up all the lamps supplied from it by the higher pressure opening valves that remain closed at ordinary pressures; and this system is widely adopted. At the Victoria Station of the Brighton Railway, the platform lamps are controlled in alternate series by cocks at the platform ends; so that the lighting of the platforms can be increased, diminished, or extinguished altogether from one point. There is in this case a constant bye-pass supply to all the lamps.

Pneumatically operated valves on single burners to enable small units of light to be lighted with the aid of a bye-pass from a distant point, have been widely adopted in recent years for both domestic and other indoor lighting; while electrically operated appliances, which light as well as turn on the gas, are also coming into use.

Mantle Life and Maintenance.

With the inverted burner the life of the suspended mantle is distinctly longer than in the case of the supported mantle, chiefly by reason of its more compact form. This is a point of great importance to illuminating engineers, in connection with the question of mantle maintenance. In this respect, the gas industry has made substantial progress in recent years, both in regard to the quality of the mantles obtainable (I use the word advisedly, as distinct from obtained) and in regard to the facilities offered by gas undertakings to consumers for the periodical inspection and cleaning of their burners and the renewal of mantles when necessary, at a fixed annual or quarterly charge. This periodical attention to incandescent burners by competent men, is commended to illuminating engineers and their clients on several grounds. First and foremost of these is that a gas company is in a position to ensure that no mantles shall be used other than the best obtainable. The low-priced, but dear, because unsatisfactory, mantle is as great an enemy to the gas industry as the low-priced but also low efficiency and short-lived lamp is to the electrical industry; and it is the business of all concerned in either industry to do everything possible to eliminate the undesirable.

A gas company can and should, as many do, submit samples of the mantles sold to them to a continuous and severe test, and ruthlessly reject the bulk when the samples fall below the highest standard. The Gaslight and Coke Company take haphazard samples out of stock every week, and submit them to photometric tests (continued at intervals over a period), and also to shock-resisting tests on a machine devised for the purpose by Messrs. Woodall and Moon. They do not issue any specification for the supply of mantles—it being a matter for competition among the manufacturers to produce the highest combination of efficiency and durability; and those who succeed secure the business, and retain it so long as they keep up to the standard they have set, and no longer. The result is, therefore, that the consumer who places his lights under a maintenance contract with the Company ensures that the mantles used will give him the best light obtainable for the gas consumed. A further result is that the burners will be freed from the inevitable accumulations of dust from the atmosphere; the glassware will be thoroughly cleaned and its transparency maintained; the necessary new mantles will be supplied—all at sufficiently frequent intervals to ensure the maintenance of a constantly good light. Another advantage incidental to a maintenance contract is that the consumer can estimate beforehand, or find out at any time, with certainty, his cost for up-keep, which otherwise, except in business houses where costs are carefully kept and closely analyzed, is a matter of doubt and consequently of uneasiness to the consumer.

I am confident that no supplier of illuminant can afford, nor ought he to be content, simply to supply the commodity and leave the consumer to work his will with it, unadvised or unassisted. I have spoken of new mantles being supplied at sufficiently frequent intervals to ensure the maintenance of a constantly good light. The question may be asked: What should be the frequency of these intervals, and how is one to determine when a mantle requires renewal because of loss of power as distinct from obvious damage? This is a question the answer to which cannot be precise, because everything depends upon the local conditions under which the mantle is used. It may, however, be stated as a general proposition, founded upon a large series of tests, that if the burner

* Five of the photographs here referred to appeared in the "JOURNAL" for Sept. 27, pp. 831-3; the other two shown are those accompanying this paper, p. 470.—ED. J.G.L.

St. James's Square. Photograph taken by the Light of Low-Pressure Inverted Gas-Burners.

receives such periodical attention as it would from an ordinary qualified maintenance fitter, a mantle that would pass a gas company's tests (such as I have mentioned) will not sensibly diminish in candle power in 500 hours, and will not lose more than 10 per cent. in 1000 hours of burning. The average of some tests made some time ago of vertical mantles, tested on the horizontal, shows a drop of 7 per cent.—namely, from 20 to 18·6 candle power per cubic foot—after 806 hours burning. The depreciation I have referred to is, of course, apart from the question of damage due to vibration or other external cause, to which, however, mantles are not now nearly as sensitive as formerly, especially when used, as they are now used to a considerable extent in London and on the Continent, for contract maintenance work without having been collodionized. In actual practice, the efficient life of a mantle on a burner properly maintained averages from about 500 to 600 lighting hours in public lamps. The "best on record" that I know of was a mantle that gave a good light in a lamp in St. James's Park for two years—say, 8000 lighting hours—and became an object of affection to the lamplighter, who was quite grieved when the mantle at last broke down.

In private installations, including factories, public houses, and other premises where the percentage of breakages from external causes is highest (and which are the first to be placed under contract when such a service is offered by a gas company), the average life is about one-half the before-mentioned number of lighting hours, leading to an average use of about five to seven mantles per burner per annum. In residences, on the other hand, the average life is generally higher than in public lamps. It is not an uncommon thing to find a mantle to last twelve months in a private house.

The quality of mantles is steadily improving in the direction of both illuminating power and durability; while the extended use of non-collodionized mantles by gas undertakings—introduced into this country by Mr. Corbet Woodall, as a result of his observations of the excellent results obtained in Berlin, where the average life of mantles in the public lamps in some districts is 1000 hours, with never a defect to be observed—promises to be of much value to the consumer by reducing contract charges for maintenance. This reference to Berlin is based on personal observation. In that city, I have inspected some thousands of public lamps; and I have never found a defective mantle in a single instance, and non-collodionized mantles are used there. I also find that in Germany, the use of non-collodionized mantles is very common for the maintenance of private installations; and they are being used very considerably in that direction in this country now.

Photograph taken by the Light of High-Pressure Inverted Gas-Burners while the Street was Wet from Scavenging.

Confidence in the Future.

In conclusion, I would say that those of us who are engaged in the gas industry, while looking back with some satisfaction upon the advance made in recent years, are by no means content to rest on our oars, but rather look forward with a lively expectation to further advance in the future. The efficiency of gas lighting, viewed as a problem of converting heat into light, is still very low in comparison with other methods—that is to say, the illuminating power produced is far less in relation to the energy consumed—say, 125-candle power per 1000 B.Th.U.—than it obviously might, and in all probability at a future date will, be, though already very far in advance of what it was in the era of luminous burner lighting.

Discussion.

The President (Professor Silvanus P. Thompson, D.Sc., F.R.S.) said Mr. Goodenough had referred to his paper as being, to use his own adjectives, meagre, dull, and uninteresting. He (the President), for one, had not found it either dull or uninteresting; and its shortness did not arise from any meagreness of internal interest. Mr. Goodenough had described the method of lighting streets by the central suspension of lamps as being, from the point of view of an illuminating engineer, radically unsound. He gave no reasons for the condemnation; and he (the President) wanted to pin him down to give some reasons for objecting to putting a lamp over the centre of the roadway. He also wished to congratulate Mr. Goodenough upon the excellence of the photographs in the paper; but he wondered how the author had been able to secure photographs of lamps by their own lights so extraordinarily free from that which was a usual defect of photographs of the kind—atmospheric glare round each lamp. In these, it was conspicuous by its absence. He hoped to hear something more regarding the question of the deterioration of mantles in modern lighting. Much had been said on this head by way of criticism of mantle lighting; but he himself thought that mantles had been unjustly condemned, because, like other means of lighting, they grew old with time. The improvement apparently effected by not collodionizing mantles was also a subject on which they would like to hear more. Regarding the discussion, he asked that the paper be discussed on its merits, and let them have the best information on the latest developments of this important branch of applied science. There was a word he should like to say as their President, and at the request of the Council. It was that they earnestly hoped, in coming that evening to the discussion of the latest forms of gas lighting, they might steadfastly avoid entering upon that which was not the subject of the paper—that was, the comparative merits of gas lighting and other illuminants. They were not there to discuss such a polemical subject. One of their distinguished visitors was Mr. Charles Carpenter, the Chairman of the South Metropolitan Gas Company; and he would ask him to open the discussion.

Mr. Charles Carpenter said he had much pleasure in complying with the President's request. In the first place, he should like to congratulate the Society on the evening's programme, for two reasons. One was the choice of Mr. Goodenough to give the paper, because he did not know of any gentleman who was more qualified to deal with up-to-date gas lighting than the author. He now had the control of (he supposed) something approaching 100 square miles of the best part of the Metropolis; and his wits were being constantly sharpened by that friendly competition of which he had spoken, with twenty or thirty electricity suppliers; and he (Mr. Carpenter) therefore might conclude that what he did not know about modern gas lighting was not worth knowing. Another reason why the Society were to be congratulated that evening was upon the presence in the chair of a distinguished physicist. He did not remember a similar occasion on which a gentleman of the scientific attainments of Dr. Thompson had taken the chair at the reading of a paper on gas lighting; and he thought the gas man might take it as a sign of the times that it was being recognized that the knowledge of gas lighting was on a more scientific basis than was the case a few years ago. While he was listening to the paper, he was reminded of a circumstance that happened some seven years since when he was attending a congress on photometry at Zurich. He was sitting in a beer garden, smoking a cigar, with a distinguished scientific man; and his friend, looking at one of the upright incandescent gas-burners, said: "What a pity so many of those rays are going the wrong way. If we could turn the mantle upside down, and use these rays below the horizontal, what an improvement it would be." One would have thought that gentleman would have been responsible for the initiation or the invention of the inverted burner; but he was not. The prophecy, however, had been fulfilled, because, when gas lighting was spoken of nowadays, they almost invariably thought of inverted burners. He considered Mr. Goodenough was right in giving so much attention to them in his paper that evening. There was one cause for the efficiency of the inverted burner that Mr. Goodenough had not mentioned. It was a physical one; and he thought it could be described in this way: In the vertical burner the particles of gases rising from the burner top were in continually increasing upward motion, and they were getting away as fast as possible from the mantle it was their business to illuminate. In the case of the inverted burner, the particles were moving vertically downwards at a gradually decreasing rate. They then come to rest; the direction of their flow was reversed; and they rose upwards. But there was that certain pause in their flow; and one might almost imagine that they were doing their duty, and giving their effect, in a still atmosphere, or in an atmosphere still in comparison with the lively atmosphere in which the vertical burner was working. At any rate, with equal pressures and equal quantities of gas, there was no doubt that the efficiency of the inverted burner flame was higher than that of the vertical burner. One of the reasons for the efficiency of the burner was the one he had explained. It was not only that the rays were turned downwards in the most useful direction, but the energy of the gas was being put to better use. There was still another matter which was, he thought, of importance to the suppliers of gas; and that had regard to the type of burner used. It was well known among gas engineers that the chemical composition of town gas as supplied was not the same in all towns. There were for this very good reasons, into which he need not enter. The burners used for obtaining light by inverted burners were supplied from various makers; and in order to localize their operations, the burners were provided sometimes with air adjustment and sometimes with both gas and air adjustment. By these means, the burner was adaptable to the special conditions regarding gas composition. A week or two ago, he saw in the "Journal of Gas Lighting" a reference to a proposal of an inventor to—instead of providing means for a variation of that kind—take the gas in each town, and select the most suitable burner for giving the best results with the particular quality of gas there, without the use of any adjustment; and he arrived at the burner that was the best by means of tests which he explained—his contention being that inverted burners of this kind should be supplied to the gas consumers. He (Mr. Carpenter) believed that was the proper system; he thought it was a disadvantage it should be necessary to have the gas or the air adjusted. In connection with the Company with which he (Mr. Carpenter) was associated, they had been making for the last eighteen months a good many experiments in this direction, and during most of the time the streets in South London had been illuminated by inverted burners having no adjustment for either gas or air. The area of the gas-jet and the area of the air-supply openings were predetermined by the pressure and composition of the gas, and they were not alterable by the lamplighter. They had also been testing during the last twelve months similar burners for indoor use; and these were just in the position of being available in South London for the winter's work. The burner had no adjustment; and it was slid into the socket on the fitting in the same simple manner as the electric lamp. London, he might say, was the most difficult city in the world for the use of the incandescent burner, owing to the large amount of dust the atmosphere contained; and therefore one of the necessities in a practicable burner was that it should be easily cleaned. The burner of which he had spoken could be taken off, blown through, and replaced in a few seconds.

Mr. C. W. Hastings remarked that the paper was a thoroughly practical one, not only to the professional man, but to the layman. Reference was made in the paper to the difficulties of pressure; and for domestic lighting, pressure was the *crux* of the whole thing. The new burner referred to by Mr. Carpenter appeared to get over many difficulties; but he should like to ask Mr. Goodenough whether, in connection with his Company, they had taken any steps for giving the consumer normal pressure—say, by putting a regulator or a governor on the Company's side of the meter. A consumer really knew nothing of the pressure of the gas with which his house was being supplied.

Mr. W. H. Y. Webber said he was pleased to have an opportunity of testifying to the value of this excellent record of the progress that had been made in the application of gas for lighting. The author had, with rare self-denial, debarred himself from some of the very interesting points that he might otherwise have made if his paper had been less of a record, and more of an active piece of propaganda for gas. As the author truly said, this was not the time for that; but, after all was said and done, combat was more interesting than writing history. He could not but help feeling this himself. He (Mr. Webber) wished to say, in reference to a point mentioned by the President, that he personally heartily supported the author in his objection to axial lighting of main thoroughfares. He thought it was the wrong place for street lamps for one or two reasons. In the first place, it put most of the light where it was not wanted. In the second place, the direction of the light was unfortunate for both vehicular and pedestrian traffic where there was axial lighting. The omnibuses travelled with their entrance side in the shadow; and it was very difficult to see the announcements on the side of the omnibuses as to their destinations. In the case of vans unloading goods at (say) a warehouse, the inside of the van was, with the lights in the centre of the roadway, as dark as a vault. It was difficult, too, to ensure that entrances of warehouses or private places were efficiently lighted as far as the main door. A friend told him once that, in walking down Cannon Street, he observed a guardian of the peace enjoying a quiet smoke in a small triangular patch of shadow in one part of the side of the street. If refuges could be so provided for guardians of the peace, they might also form refuges for objectionable persons. Light in the streets was really required more for pedestrians than it was for the central line of the thoroughfare, which was scarcely used, except by firemen. There was a very interesting reflection in connection with this paper. It was that most of the improvements—the advancement in brilliancy—spoken of by the author were due to the infinite pains taken by those who had laboured in this department of engineering. The actual elements of present-day incandescent

burners remained as they were a good many years ago; but there was no doubt whatever that, by the constant application of skill and observance upon the part of manufacturers, helped by the criticism of officers of gas companies like Mr. Goodenough, the net result had been a very considerable improvement in the efficiency of all classes of gas-burners.

Dr. Rudolf Lessing, referring to the statement in the paper as to the high efficiencies of inverted incandescent burners being due to the high flame temperature, said he thought the words put the whole question of the high efficiency of the inverted burner in a nutshell. There was no doubt that the temperature of the incandescent body was, after all, the factor that regulated the light that was emitted from it; and he thought it had been proved that, in the range of the temperature of the bunsen flame—from 1500° to 1900° C.—an increase of about 100° C. was capable of doubling the lighting effect to be obtained from the incandescent burner. Thus it was certainly the temperature of the body of the incandescent mantle that regulated the efficiency. The temperature was conditioned by several factors. First of all, by the flame temperature itself. As those present were well aware, the bunsen flame was dissected into different cones at different temperatures. Allowing a flame to burn as they had it in the laboratory bunsen burner, they had an inner cone which was comparatively cold, while the outer cone, which received sufficient air to allow the theoretical combustion to take place, was very hot. The inner cone was much cooler than the outer one—a difference of something like 300° was possible. If they added to the gas sufficient air to obtain the theoretical mixture, and therefore the best possible combustion throughout the flame, they would be in the position to place the body of the mantle in the hottest zone. On the other hand, the length of the flame would be considerably shortened; and a second advantage was obtained—that the heat that had to be given out by the flame as a whole was more concentrated. They had not only the total possible heat given out by the flame; but the heat was concentrated on the body which had to be heated to emit light. Therefore the regulation of the air supply seemed to him to be necessary. He should not like to question Mr. Carpenter's statement as to the advantage that would, and no doubt did, accrue from burners that could be used without the regulation of the air supply. The majority of burners possibly went into the hands of people who were not capable of handling the minute adjustments they required. On the other hand, he did not think every gas undertaking was in the happy position, as was the one over which Mr. Carpenter presided, to supply gas of something approaching uniform composition; and the majority of gas undertakings had to be considered as well, seeing that adjustment of the burners in their areas would appear to be necessary. The temperature of the flame was dependent upon the air supply. But there was another point—the one quoted in the paper—as to the preheating of the gas and air mixture. Putting together all the factors that would possibly control the available heat of the flame, they would be the amount of heat developed, the volume and temperature of the products of combustion and their specific heat, and the temperature of the gas and air mixture brought to the point of ignition. The volume of the gases and the specific heat were responsible for all the heat that would be abstracted by the excess of air, and this had to be avoided as far as possible. On the other hand, the preheating would allow the mixture to be ignited at the optimum point, and thus give the best possible conditions. In putting the regenerative system of preheating into any lamp, they were in a better position to see the scientific basis underlying the whole question than they were a few years ago. It was now possible to bring lamps to such a nicety that the excess of air in the products of combustion was reduced to a minimum, so that the maximum heat, or nearly obtainable maximum heat, was applied to the heating of the incandescent mantle. The preheating of the gas-air mixture was dependent on the temperature, velocity, and heat conductivity of the flue gases and on the surface and temperature of the wall separating the air supply and flue-gas exit. To allow of a rapid exchange of heat, the endeavour must be in the direction of keeping a large surface, which should be as thin as the construction would allow without deterioration by the heat applied to that part of the lamp. The factors quoted were nearly all constant in any case; but there was one—the temperature of the flue gases—that largely influenced the efficiency of the lamp. Its maximum could be easily determined by simple means—that was, by analyzing the flue gases. If they did this, they could find what, if any, excess of air was present in the flue gases. He called to mind one or two cases of modern high-pressure inverted lamps, where it had been possible, after ascertaining these conditions and drawing the practical conclusions by constructional alterations, to reduce the excess of air by about 30 or 40 per cent. of the excess present in previous designs, with a consequent increase to the same extent in the efficiency of the lamp.

Mr. W. J. A. Butterfield (called upon by the President) said he did not expect to have the opportunity of speaking; and Mr. Goodenough had covered the ground which he set out in his paper to deal with, so fully and so clearly that there was very little that one could fix upon—certainly not for criticism, and very little to enlarge upon. In regard to the question of central suspension lighting, he quite agreed with the author that it was highly objectionable, not only on the grounds that Mr. Webber had referred to, but because overhead wires in the streets were objectionable on account of their interference with the raising of ladders and fire escapes. The objection equally applied to tramway conductors. Regarding the question of maintenance charges, when, some seven years ago, he was preparing a text-book on a rival illuminant to town's gas, and since when revising the work, he was very glad, although he knew the facts in regard to town gas, to have indisputable figures in regard to the cost of gas lighting, inclusive of maintenance. It was not difficult to obtain the average photometrical value of a gas-lamp; but those responsible for rival illuminants constantly wondered whether the maintenance charges were not much higher than those responsible for gas-lighting represented. The fact that a gas company would undertake to maintain a burner for so much per year or per quarter gave a sure basis of computing the absolute cost for gas lighting per annum for a good light. Then in regard to the life of mantles, speaking purely in a domestic capacity as a householder, he had had in the case of one burner a very favourable experience. The first mantle on this burner lasted well. It was a No. 3 or No. 4 Kern burner; and the mantle continued in good condition for three years, with a falling-off in the light of not more than 15 per cent. A second mantle on the same burner was now in use, and had been running for two-and-three-quarter years. This was in the entrance hall in his house, where it was exposed to draughts. But this was admittedly an exceptional case. Speaking generally, he agreed with Mr. Goodenough that the life of the inverted mantle was considerably higher than that of the upright mantle. He could also fully confirm what Mr. Carpenter had said as to the efficiency of the burners for inverted lighting in which there was no air or gas regulation, when the burners had been standardized for the particular gas which they consumed. He had watched the work of the burners designed by Mr. Carpenter both on the coal gas (which, as Dr. Lessing had said, was of uniform composition) in South London, and also on the mixed gas supply in the South Suburban district; and the results obtained in both areas were eminently satisfactory. It was curious they were coming back to fixed conditions in the burner for lighting between the air and gas supply, while the heating apparatus makers were going in the other direction for stoves.

Mr. A. E. Broadberry (Tottenham) said he much wished Mr. Goodenough had dealt with some of his points at greater length, because many of them were capable of a great deal of development. But he could quite appreciate his reasons for denying himself the opportunity that he had had. With regard to high-pressure lighting generally, he (Mr. Broadberry) had not the slightest doubt that distribution pressure in gas supply would be a constantly increasing one—not only for what was known as actual high-pressure purposes, but also for ordinary purposes. He thought gas supplies would be constantly, though gradually, on the upward trend as to pressure; and as they proceeded in this direction, they would likely develop much better efficiencies. In the earlier days of incandescent gas lighting, burners were adjusted for 1 inch water pressure; but it was very soon found that higher efficiencies were to be obtained by higher pressure; and the tendency had ever since been upwards. Personally, he felt that they were merely on the outskirts of what could be obtained from gas, and that they would go on advancing their efficiencies, so that in a few years' time they would look back on the present systems as being as old-fashioned as those of ten years ago were regarded now.

Mr. S. E. Thornton (Chairman of Messrs. William Sugg and Co., Limited) said he thought that not only professional men, but the general public were interested in the subject of Mr. Goodenough's paper; and he hoped it would be circulated broadcast. There was no doubt that inverted burners were the best things for lighting the streets. But they had some beautiful public buildings in London; and their external illumination ought to be considered. They could by illuminating them get some very artistic effects in the streets.

Mr. R. W. Edwards (Aldershot), while warmly congratulating Mr. Goodenough, felt constrained in the same breath to reprove him, because he had restrained himself to the disadvantage of those present who would have liked a little more information on some of the points treated upon. Perhaps Mr. Goodenough considered it inadvisable to give too much detail at present; but no doubt at some later date he would supply them with information in the fullest sense. Dealing with the first question of maintenance, they would like to know whether, from Mr. Goodenough's experience, he had found it best to take on consumers' maintenance at an inclusive charge per quarter or per annum, whether the payment included labour and mantles *ad lib.*, or whether, as opposed to that, he would recommend a system of providing the materials at cost, or something near to it, and supply the labour free; or whether he would suggest doing the labour at so much per burner (say, 1d. per burner per visit), and charge for the material. He (Mr. Edwards) would be personally interested in information on the point from the author. Like the President, he had an adverse opinion to Mr. Goodenough in regard to the question of lighting across the street. Some years ago, he remembered a street in Liverpool—a somewhat narrow street—that was lighted by slung central lights, to the great advantage of the thoroughfare; and, in narrow thoroughfares, he did think the cross or central lighting was much more efficient than side lighting. Side lighting was unquestionably better in wide thoroughfares with broad footpaths. As to the high-pressure distribution in the West-end, he should like to know whether the gas was compressed at a central station, or decentralized; what was the motive power used; and was there

any auxiliary power? He should also be pleased to learn whether Mr. Goodenough had any experience where the gas and air were mixed at the compressing plant, as at the Brighton Railway Station. Mr. Carpenter had mentioned that in South London he was able to supply burners without any means of regulation. He (Mr. Edwards) was rather surprised at this; and he must say it spoke well for the manufacturing arrangements at the gas-works. But Mr. Goodenough would agree that the use of such a burner would be somewhat difficult in districts where mixed gas was supplied. It was impossible to get the same evenness in the composition of the gas where a mixture was distributed as was necessary for such a burner; and therefore, in his opinion, the regulation of burners was advisable.

Mr. CARPENTER asked to be allowed to add that the non-adjustable burner to which he had referred had been working privately under his own observation in Westminster, on the gas supply of the Gaslight and Coke Company, with complete success for the last twelve months.

The PRESIDENT said that one gentleman had expressed some surprise that mere physicists should take an interest in such a subject as gas lighting. He (the President) thought the mere physicist should take an interest in gas light; for it was a thing of scientific invention. Not a great number of years ago, they were only getting 2 or 3 candles per cubic foot of gas consumed; now it was possible to obtain 70 candles by the use of mantles and high pressure. Such an extraordinary improvement—the result of the consumption of material obtained by strictly scientific means—was most interesting for the scientific man from whatever quarter he might come. The room of the Society of Arts in which they were assembled had been the centre of scientific wonders for over a century. It witnessed the birth of gas lighting; and there were discourses there when Winsor laid the first gas-pipes in London for the Chartered Gas Company. He (the President) himself had heard a lecture in the room, in the seventies, in which the lecturer was confident he had lived through the gas era. Now they had Mr. Goodenough showing them that the era of real gas lighting had only just begun.

Mr. GOODENOUGH, in reply, remarked that his paper had been criticized as being too short. He thought the shortness of the paper was justified by the fact that it had given time for the discussion; the remarks that had fallen from the various speakers having been more valuable than anything he was himself able to say. Dealing first with the President's challenge as to why he considered the lighting of the roadway by lamps suspended over it as unsound, Mr. Webber had partially answered the question. The light tended to throw shadows from vehicles on to the pavement; and a person trying to see the destination of an omnibus had the disadvantage of having the side of the vehicle in shadow instead of in light; and if he attempted to get into the vehicle, he also found the entrance in shadow. There was another very strong objection to the lighting of the roadway by suspension lamps. It was this: They had to have the lamp sufficiently high above the roadway for the wires to be cleared by the passage of fire escapes or tall ladders; and if they were put sufficiently high to ensure anything like the distribution of light on to the pavement, they were so high that, if there was a fog, there was not the slightest chance of the road and pathways being lighted by the lamps, situated (say) 28 or 30 feet above the roadway. Most of them had had experience of fogs in London. He had looked down from one of the windows of his flat through the clear upper air on to a dense bed of fog underneath, with an arc lamp shining merrily above the fog. He had gone down, and stood at the foot of the column, and could not see the light, though the lamp was only 18 feet above the road-level. If the height of such a lamp was increased to (say) 28 feet, the chances of the light finding its way down to the street when a real fog prevailed, were very remote. He had to thank Mr. Carpenter for the very complimentary remarks he had made; and he did feel that the paper had been justified if only by securing Mr. Carpenter's presence, and hearing what he had to say on gas-lighting matters, upon which he was such an eminent authority. He (Mr. Goodenough) was particularly interested in Mr. Carpenter's explanation of the causes of the efficiency of the inverted gas-burner as against the upright form—an explanation that had not previously occurred to him. He was glad that Dr. Lessing confirmed him in his belief as to the main cause of the increased efficiency. Particularly interested would he be to see and to test the burner of which Mr. Carpenter had spoken with its fixed gas and air supply; more especially as Mr. Carpenter was able to assure them that it had been found to work with perfect satisfaction upon the Gaslight Company's supply—namely, a mixture of coal and water gas, distinct from the straight coal-gas supply in South London. He had quite an open mind on the subject. There was one point that occurred to him, and it was that the adjustable nipple by which the supply of gas was regulated served the double purpose of regulating the gas and of clearing the nipple from any temporary obstruction that might be in it without dismantling the lamp for the purpose. A turn of the regulating-screw to and fro, so as to drive the needle through the injector and back again, would often improve—would often make a substantial improvement in—a defective light. Mr. Hastings raised the question of pressure. The variations of pressure in a district were not, as he had said in his paper, by any means so material as at one time they were. Owing to the considerable higher average pressure that was now in use in the district—say, 3 inches instead of perhaps 1½ inches as formerly—a ¼-inch variation in pressure was not nearly so high a proportional variation as it was when pressures were lower—that was to say, a difference between 1½ inches and 1¼ inches was proportionally much greater than a difference between 3 inches and 2¾ inches. He had been told by a gentleman interested in the manufacture of instruments of precision in regard to pressures and so forth, that he had never found in his experience a straighter line on his recording-gauge than he found in Westminster nowadays. A great deal, of course, depended on the adequacy or inadequacy of the internal fittings. If the fittings internally were of a limited character, then there would be variations in pressure (even though the district pressure was constant) according to the demand made upon the supply. This was a point upon which they would be glad if architects would consult the gas company when drawing up their specifications for the piping of premises. There was a great tendency to put in internal piping when houses were in course of construction that was altogether inadequate. With adequate fittings, there was little need in most districts for pressure governing; but where internal fittings were at all on the small side, it was undoubtedly a great advantage to fix a governor on the outlet or inlet of the meter, so as to secure a constant pressure at the burners whatever the demand might be. Mr. Butterfield gave them some interesting experiences in regard to the life of mantles. He (Mr. Goodenough) was interested to read in the "JOURNAL OF GAS LIGHTING" that day a report from the Chief Inspector of the Brentford Gas Company of their experience in the use of mantles on high-pressure lamps at the Japan-British Exhibition, where their average for six months was not two mantles per burner. This would probably give five mantles per annum, allowing for the fact that the months of use were summer and not winter ones. Mr. Thornton's suggestion as to the illumination of fine public buildings would commend itself to gas and electric lighting companies, but perhaps not to the ratepayers. [Laughter.] Anyway, he (Mr. Goodenough) would welcome the adoption of the suggestion. Mr. Edwards asked for an expression of opinion as to the best system of charging for mantle maintenance—whether he would advise an inclusive charge (a fixed price per annum or quarter to include all materials and labour), or whether he would recommend materials at cost and labour free. He was a strong advocate of the system of charging fixed prices per burner inclusive, because he did not like leaving to the decision of a consumer whether a mantle should be continued in use or not. If a consumer had to pay so much per mantle, according to the number of mantles used, the consumer's tendency would probably be (as it was when they looked after their own mantles) towards economy rather than efficiency. He (Mr. Goodenough) preferred that it should be a matter for the decision of the gas company's fitter as to whether or not a mantle was required rather than leave the decision to the consumer, if the consumer had to pay. For these reasons, he strongly recommended an inclusive charge per annum or per quarter. Mr. Edwards also referred to central lighting for narrow streets; and, for such purposes, he (Mr. Goodenough) thought that bracket lighting was preferable as freeing the streets from any obstruction from columns, which were perhaps a nuisance in narrow thoroughfares. A great majority of the narrow streets in the City were well lighted from brackets. Then, Mr. Edwards also asked as to the system of high-pressure distribution. The Gaslight and Coke Company were supplying high-pressure gas for lighting in Westminster from a central station at their head office in Horseferry Road—the compressors being run by gas-engines with adequate stand-by; so that if one engine was not available, another was. In regard to the question of supplying a mixture of gas and air at the compressors, instead of the mixture taking place at the burner, they had not put in any installations of this nature themselves, but there were one or two on their district. The suggestion that more standards should be used in the streets was one that was rather difficult to deal with, because there was such an enormous variation as to the number of standards that were used in streets. In some streets, the number of standards was very considerable per thousand yards; in others, very scanty. Personally, he favoured the use of a number of units of moderate power, placed not too high above the ground, rather than lighting the streets by high units placed a greater distance apart, and fixed higher above the ground-level. By these means, better uniformity in the distribution of illumination was obtained.

The PRESIDENT remarked that, as to central lighting, he was not adopting any position of antagonism to the author. He had thought that the whole point of Mr. Goodenough's objection was the question of suspension. He was not an advocate for central pillars; and suspension did not appear to him to be much worse—except from the fire-escape point of view. There was one other matter to be referred to. They had had certain questions prepared by the Hon. Secretary in anticipation of this meeting and discussion; and two correspondents had sent certain answers to some of the points. One of the replies was from Mr. Keith. In it he touched upon a matter that had been mentioned. He asserted that it was impossible to give any fair statement as to the maximum efficiency in candle power per cubic foot of gas by the high-pressure burner unless the kind of gas was specified; but he added that, with an average kind of gas, using high pressure, he obtained 60 candles per cubic foot. With extra good gas, he had got as high as 73 candles per cubic foot; and 120 candles with specially good oil gas. In Mr. Keith's opinion, too, the most accurate way of expressing the illuminating power of a lamp was to take the mean lower hemispherical power.

On the motion of the PRESIDENT, a hearty vote of thanks was accorded to Mr. Goodenough.

SULPHATE MANUFACTURE FOR SMALL WORKS.

By Philip G. G. Moon, F.C.S.

[A Paper read before the Southern District Association of Gas Engineers and Managers, Nov. 10, 1910.]

Ammonia, the residual from which gas undertakings of a fair size expect to make a respectable profit, is to very small works often nothing but a nuisance and a source of loss. Any ammoniacal liquor that may be made presents great difficulty in its disposal, as the cost of carriage absorbs all the profit on its sale, unless the works are very favourably situated; and the capital expenditure necessitated by the installation of a sulphate of ammonia plant of the ordinary type would not in most cases be justified, in view of the small quantity of liquor to be dealt with and the fact that the plant would be standing idle for (say) eleven months during the year. Furthermore, sulphate plant of the ordinary type requires constant attention of a more or less skilled character, and monopolizes the whole time of one man while it is in operation.

It is, therefore, not an uncommon thing to find that in a small works no attempt whatever is made to recover ammonia from the gas. The water in the purifier lutes and gasholder tanks is converted in time into weak liquor; and the gas distributed to the consumer is full of free ammonia. The inevitable result is trouble on the district caused by the sticking of taps and the corrosion of burner nipples and fittings. The weak liquor that is unavoidably produced on the works is allowed to drain away, either into some adjacent water course or into the public sewer, and is bound sooner or later to give trouble.

The works at Wareham, supplying about 5 million cubic feet of gas per annum, were in much the above plight about eighteen months ago. We were concerned as to how best to improve matters; and on the suggestion of Mr. Wilton, we decided to instal a small experimental plant on what are, I believe, somewhat novel lines—at any rate, in ordinary coal-gas practice. At Wareham, there is only one man on shift by day and one by night, with the manager to read meters, do all necessary fitting work on the district, and attend to public lighting, &c. Obviously any plant to be successful would have to be so simple that an ordinary country workman could not fail to understand it, and so arranged that it would not entail any considerable extra labour on the staff.

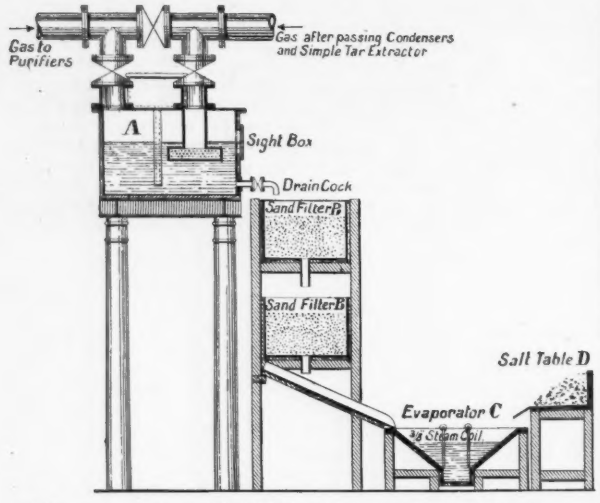


Fig. 1.—Arrangement of Sulphate of Ammonia Plant at Wareham.

The plant installed at Wareham is shown in fig. 1, and has now for several months proved to admirably fulfil the above conditions. The coal gas, after passing the condensers and a small purifier filled with heather, which acts as a somewhat crude tar extractor, enters the lead saturator A, and bubbles through the weak sulphuric acid contained therein.

We have proved by careful experiments that there is no apparent loss of illuminating power due to the absorption of hydrocarbons from the gas, so long as the strength of the acid is kept below 4° to 5° Twaddel. In starting the acid washer, therefore, the acid is mixed to about 3° Twaddel. At this strength, the avidity with which it will absorb the ammonia renders it unnecessary to work with more than 1 inch to 2 inches of seal in the washer. Sulphate of ammonia is formed in solution; and the specific gravity of the washing liquor slowly rises.

A simple calculation gives approximately the amount of sulphuric acid that should be added from day to day to neutralize the ammonia produced from the amount of coal carbonized per twenty-four hours. This amount is added to the saturator in half quantities each twelve hours. Roughly, about 23 lbs. of acid of 142° Twaddel would be required per ton of coal if all the fixed and the free ammonia had to be neutralized. Where the free ammonia only is dealt with, as at Wareham, about 13 to 16 lbs. only is required. These amounts will, of course, vary according to the kind of coal carbonized and the heats used. Adding acid in this way, in the quantities necessary only for each day's make of ammonia, the specific gravity of the washing liquor increases regularly; but the amount of free acid in solution is never high enough to affect the illuminating power.

When the strength of the solution reaches 45° to 50° Twaddel, it is drawn off in small quantities each day, so as to keep the seal approximately constant, passed through the two small wooden, lead-lined filters BB (filled with sand on a layer of felt), and, when enough has accumulated, transferred to the evaporator C. This, at Wareham, where exhaust steam is available from the exhauster engine, is a wooden, lead-lined vessel of the shape shown, with a flow-and-return lead pipe for the steam. Very little concentrating is needed, as at 45° to 50° Twaddel the sulphate of ammonia solution is very near crystallizing point.

In works not using an exhauster, and therefore with no steam available, a cast-iron lead-lined evaporator of convenient shape, sitting either on the waste-gas flue or on top of the beds, would be quite effective. Crystallization soon takes place, and the salt is put on the draining board D to drain; the small amount of mother liquor left being mixed with the next batch for concentrating. Very good coloured salt is made by this process; and the sample of Wareham salt exhibited gives an analysis of 25·2 per cent. of ammonia. A good local sale can usually be cultivated with very little trouble, as most small works are of necessity situated in a country district.

In a small works such as Wareham, the amount of virgin liquor from the hydraulic main is hardly sufficient to warrant the installing of a lime still to liberate the fixed ammonia. But the whole of this liquor, and the stronger liquor from the condensers, is pumped through the hydraulic main twice; so that as much free ammonia as possible is driven off into the gas. The virgin liquor run to waste at Wareham amounts to approximately 11 gallons per ton of coal, containing free ammonia equal to 1·1 lbs. and fixed ammonia equal to 4 lbs. of sulphate. This is equivalent to a total waste of 5·1 lbs. of sulphate of ammonia per ton. The plant has been working for three months; and over this period 14 lbs. of sulphate of ammonia have been made per ton of coal carbonized. In addition to this, gas entirely free from ammonia has been distributed, and the waste liquor to be disposed of has been considerably reduced in both strength and quantity.

It is necessary with a process of this kind to keep the saturator liquor constantly on the acid side. If it were allowed to become alkaline, sulphuretted hydrogen and carbonic acid would be absorbed; and when the next acid was added, these gases would be given off in considerable quantities. The purifiers would be overtaxed by the burst of sulphuretted hydrogen, and the illuminating power of the gas would certainly suffer temporarily from the extra carbonic acid if oxide only were used for purification. Fortunately, it is quite easy to avoid this trouble.

With regard to the financial side of the question at Wareham. As there is no fuel or labour bill to be met, practically the only charges against the sulphate sold are the cost of the acid used and the interest and depreciation on the plant itself. The capital outlay is, however, so small, and the wear and tear of plant so inappreciable, that these charges do not amount to very much per ton. I estimate that, selling the sulphate of ammonia produced at £11 per ton, there will be a net profit of £7 per ton sold. This will yield a total profit for the year equal at Wareham to an increased dividend of 0·6 per cent.

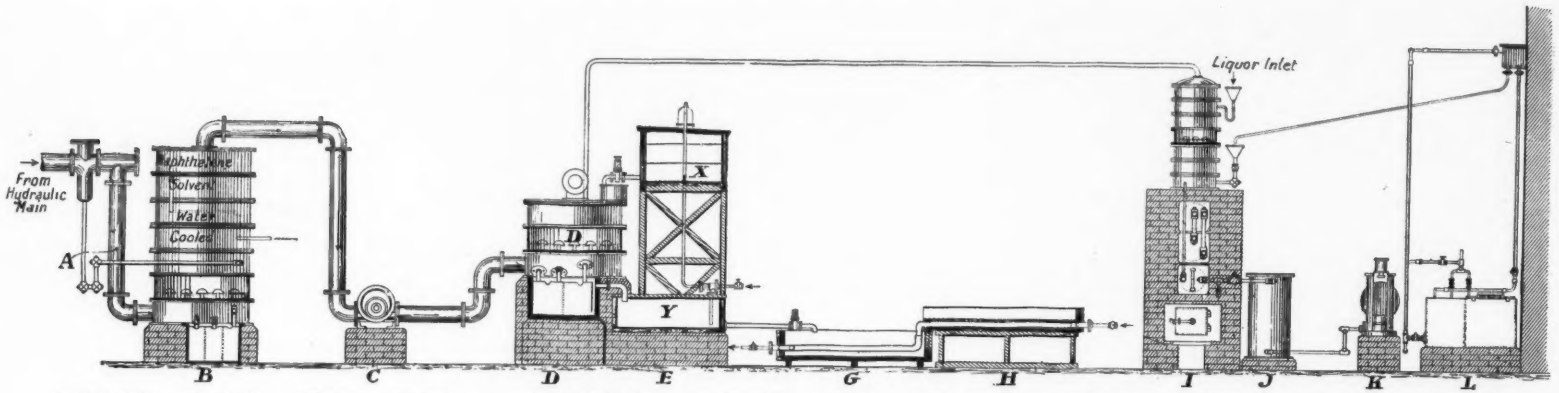
What has been done at Wareham on a very small scale, has been done on a larger scale, and therefore much more thoroughly, at Dunstable, by Mr. Phillips, who has kindly accorded to me permission to give you the particulars of the plant and his experience with it up to date. At Dunstable, between 2000 and 2500 tons of coal are carbonized per annum; and the fixed ammonia therefore is sufficiently significant to be worth recovery. The gas as it leaves the hydraulic main is passed through a specially constructed condenser-washer, so arranged that, as the liquor condenses, it flows in a reverse direction to the gas, and leaves the apparatus warm and containing very little free ammonia.

This liquor is conveyed to a direct-fired distillation apparatus, where it is treated with alkali and the ammonia driven off to the acid washer through which the main stream of gas passes. The spent liquor, which averages about 10 gallons to the ton of coal carbonized, is conveyed to a shallow tank on the top of the retort-bench, and is evaporated to dryness. It will be seen that the quantity of effluent by this system is only about one-fourth of that which would be produced by the ordinary method of water washing and steam distillation. Thus at a small works carbonizing (say) 10 tons of coal per day, there would only be 100 gallons of effluent to dispose of; and this, if desired, could be easily evaporated in the ash pans.

Referring to fig. 2, B shows the fractional condenser-washer, consisting of six bubbling trays each working with a seal not exceeding ½-inch. The hot gases from the hydraulic main enter the washer at the bottom, and pass upwards through all the six trays. The two top trays may be used as naphthalene washers by filling them with a suitable solvent, such as oil tar, which also serves to remove the last traces of coal tar from the gas. The middle two trays are provided with cold water circulating pipes, which may be adjusted so that the exit gases are reduced to any desired temperature. The bottom two trays receive the condensed liquor from the trays above, and also the tar and liquor from the hydraulic main. The hot gas bubbling through the liquor in the

two trays raises its temperature considerably, drives off most of the free ammonia, and the liquor passes away from the washer at about 100° to 120° Fahr., or very little lower than the temperature of the inlet gas.

Through the exhauster C, the gas now passes to the acid washer D. This is arranged with trays so that the gas is washed three times. Sulphate of ammonia solution is formed, and is constantly circulated through the receiver Y and overhead tank X. Acid is added at intervals, so that the liquor entering the washer contains 1 per cent. and leaving the washer only 0·1 per cent. of free acid. The strength of the sulphate liquor gradually increases; and when it reaches 45° to 50° Twaddel, it is run off to the evaporator G, where it is concentrated by means of a small steam coil and crystallized. The salt drainer H is also provided with a steam-coil, so that each batch of sulphate can be dried before removal—thus making it unnecessary to have a lead-lined store.



A. Gas Main. B. Condenser Washer. C. Exhauster. D. Acid Washer. E. Spent Liquor Tank. G. Evaporator. H. Drainer. I. Direct-Fired Liquor Still. J. Spent Liquor Receiver. K. Pump. L. Liming Apparatus.

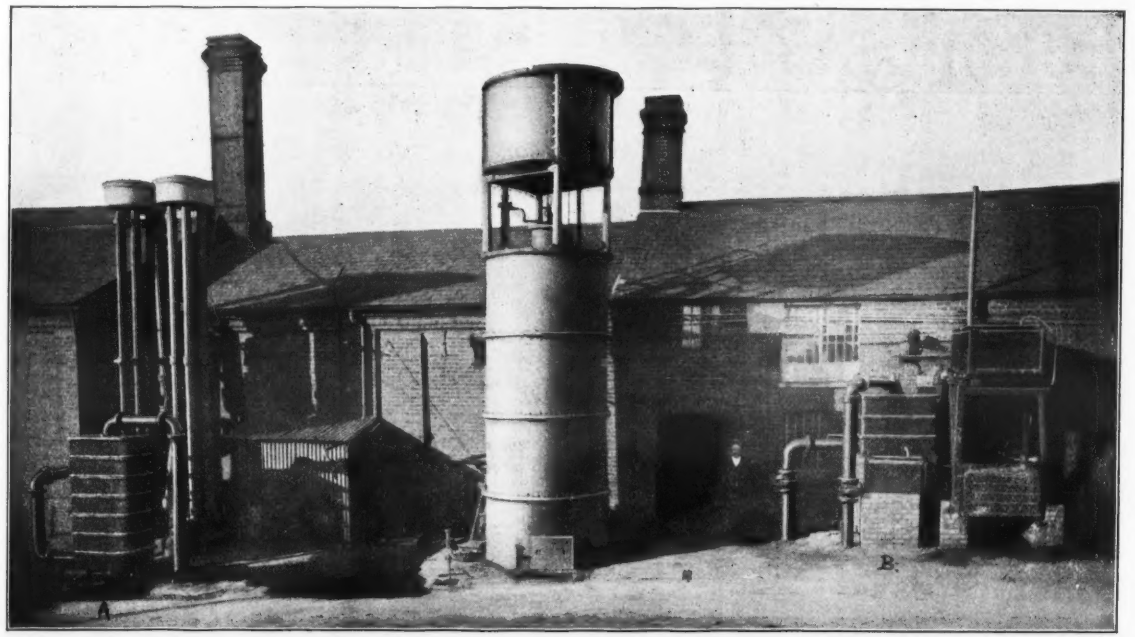
Fig. 2.—Arrangement of Sulphate of Ammonia Plant at the Dunstable Gas-Works.

The virgin liquor containing the fixed ammonia is pumped from the outlet of the condenser to an overhead tank, from which it flows by gravity to the direct-fired still I. A direct-fired still is used in preference to the usual type, so as to prevent the increase in bulk of the effluent liquor due to the condensed steam. It is easy to operate; and it is of importance to note that the lime deposit does not adhere as with steam, and is therefore quite easy to remove. Finally, the effluent liquor is pumped into two tanks 8 ft. by 3 ft. 9 in. by 6 in. deep, laid on the top of the retort-bench, where it evaporates to dryness.

The whole plant is exceedingly simple to operate, and does not call for any increase whatever in the works staff. Liquor-tanks become quite unnecessary, and there are by this process no smells of free ammonia and sulphuretted hydrogen about the works. There is no effluent, and no possibility of nuisance of any kind; and the Alkali Inspector will, I venture to think, not find it necessary to visit any works manufacturing sulphate in this way. It has not yet been possible at Dunstable to obtain figures with regard to the make of sulphate per ton of coal; but as there can be no escape of ammonia at any point in the process the yield must of necessity be fairly high. The first plant installed at Dunstable was hardly so complete as that described; but it was sufficiently successful to warrant the construction of the more complete system outlined above.

Engineers who have seen the process in operation at Dunstable have been considerably impressed with its simplicity and efficiency; and at the time of writing this paper, at least four engineers have placed orders for similar plants.

The only criticism that can, I imagine, be made on a process of this kind is that one loses the purifying power of the ammonia for the partial removal of carbonic acid and sulphuretted hydrogen. If the best use possible by ordinary scrubbing methods is made of the ammonia, about 200 to 300 grains of carbonic acid and 100 to 120 grains of sulphuretted hydrogen per 100 cubic feet of gas are



The Dunstable Gas-Works Sulphate Plant, showing the New Washers A and B, and the Condenser and Scrubber out of action.

removed by the scrubbers. In works using oxide only for purification, the extra sulphuretted hydrogen would be absorbed by the purifiers without trouble, and the carbonic acid would pass forward into the gas, increasing the volume by about 0·5 per cent. and reducing the illuminating power by about 0·3 candle. In most small works, this would be quite unnoticed, and would in any case be well within the ordinary variations of illuminating power. Where lime only is used, the net result would be a slightly increased use of lime, the cost of which would be much more than covered by the profit from the sulphate, and the great advantage of distributing gas free from ammonia.

As a matter of fact, in most small works anything like full duty is very seldom obtained from the ammonia as a purifying agent for carbonic acid or sulphuretted hydrogen, and the additional quantities of these gases passing to the purifiers would not amount to anything like the figures given above. Although the process up to the present has been applied to small works only, it has advantages which, under special local conditions, might make it worthy the attention of much larger undertakings. Scrubbers, either of the tower or rotary type, and large liquor storage tanks would become quite unnecessary, and the waste exhaust steam that abounds in many works could do the necessary work instead of the plentiful supply of live steam required by the present methods. In addition to this, one would have a practically continuous process of manufacture instead of an intermittent one.

In conclusion, I should like to take this opportunity of thanking Mr. Phillips for his kindness in placing the particulars of the Dunstable plant at my disposal, and Mr. George Wilton for the help he has given me throughout.

Discussion.

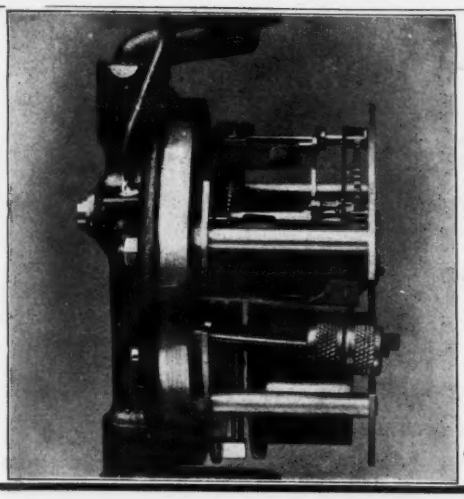
The Chairman (Mr. H. C. Head, of Winchester) said they were very grateful to Mr. Moon for bringing forward a subject such as this—a subject which dealt with the improvement of very small works. For many years very small works had been neglected; and he feared that in most places they were disreputable little holes. The gas sent out had most of the ammonia left in it; and it was very unpleasant to use, and the effluent from the works was exceedingly disagreeable. Mr. Moon had given a very complete description of a sulphate plant suitable for small works; and this plant would, he (Mr. Head) was sure, be well worth the consideration of those who had anything to do with very small works. The description was most complete; and the author had foreshadowed to them where difficulties might arise, and how to avoid them—in fact, he thought he had told them all about the plant excepting the cost. This was a point they would like to hear something more about. One other point he had not mentioned, and that was whether any difficulties were likely to arise in using such a plant in a works where there was no exhauster. Many of the small works (which were only one-man works), making 2 or 3 millions a year, had no exhauster; and anything that increased back-pressure was of importance.

Dr. Harold G. Colman (London) said the paper Mr. Moon had read was in many respects a very timely one; and from more than one point of view. One the Chairman had already expressed —namely, that it was of great importance that matters of advantage to small works should be brought forward at their meetings. Apart from this, it was a very timely paper because the question of the methods of the removal of ammonia from gas was at present very much in the air. From the time that ammonia recovery from gas was regularly carried out, practically the process with which they were most familiar, and which was universally employed, was the use of water for washing out the ammonia. When about ten or twelve years ago the Mond process was brought out, this method of removing the ammonia proved disadvantageous on account of the large volumes of gas dealt with, and great dilution of the ammonia in the gas. And therefore they had recourse to absorption by dilute sulphuric acid. Curiously enough, for very different reasons, ammonia recovery by the use of water had proved more or less a failure in small works; and here again they were having the process which Mr. Moon had so ably put before them, in which the ammonia was recovered by the action of dilute acid. Further than this, in connection with bye-product coke-ovens, ammonia recovery directly from the gas by means of sulphuric acid was at present being largely undertaken. In the two processes that were now being adopted to a considerable extent—the Otto-Hilgenstock and the Koppers processes—a stronger acid was used, and the sulphate was obtained by direct treatment of the gas with sulphuric acid. At the present time, as most of the members were aware, several attempts were being made to get the direct recovery of sulphate of ammonia from the gas by utilizing the sulphuretted hydrogen which it contained to form the sulphuric acid. The two processes which were now being experimented with on a fairly large scale, and to the results of which they were looking forward with a considerable amount of interest, were the Feld process on the one hand, and the Burkheiser on the other. It seemed as though, in the course of the next few years, the gas manager would have added to the perplexities which already faced him with regard to the best system of carbonization, further perplexity as to what was the best system to adopt to remove the tar, ammonia, and sulphuretted hydrogen. Turning now to the actual process under consideration, he had little to say, because the plant that Mr. Moon had described seemed very well suited to the necessary conditions of small works. It was simple; it was inexpensive in construction; and it was of such a character that an ordinary workman was quite capable of looking after it. There was one point he should like to ask Mr. Moon. It was whether he had found (though most probably the time was too short to show it) in the subsequent purification, which he (Dr. Colman) presumed was done with oxide of iron, any difficulty whatever with the oxide. The reason he asked the question was this: It seemed to him there might be some difficulty in this respect, owing to the gas being absolutely free from ammonia. So long as the gas passing through the oxide was slightly alkaline (which was always the case when the gas was washed with water only), the iron sulphide formed revivified readily on exposure to the air, reforming oxide of iron. If, however, ammonia was entirely removed, and the gas entering the purifiers was neutral or slightly acid, as might easily be the case when the ammonia was removed by sulphuric acid, iron pyrites (FeS_2) was sometimes formed. This sulphide did not revivify on exposure to air. If such a difficulty should occur in this case, it would be quite easy to overcome it. All that would be necessary would be to bye-pass a small quantity of gas containing ammonia to the purifier inlet. It would contain sufficient ammonia to keep it slightly alkaline, and so prevent the formation of iron pyrites.

Mr. W. B. Randall (Waltham Cross) said it would perhaps be interesting to the members if he stated that he had the pleasure of seeing the plant at work at Dunstable a few weeks ago; and, as far as he could see of the process, he came to the conclusion that, to many small works and to many medium-sized works, it was undoubtedly applicable. The author had so ably presented the points of the plant and process that there were few left to criticize. When he was at Dunstable, he made certain inquiries. One was in regard to the matter Dr. Colman had referred to. Although not using water, the oxide revivified exceptionally well, and the purifiers lasted longer than they did before the plant was put in. The point in which he was interested was that of reducing the bugbear which he was sure most gas-works would suffer from more or less in the future—namely, the question of the spent liquor; and he thought that here was a great step towards the solution of the problem. There was not the least doubt that near the London district more especially, where the Metropolitan Water Board had great powers, they would be compelled to purify the liquor to a much greater extent than they had done in the past; and if they could decrease the amount of this by two-thirds—say, 10 gallons, instead of 30 gallons—it would be a great step towards the solution of what would probably be a difficult question in the future.

Mr. Harold W. Woodall (Bournemouth) said he did not think he had anything to add to what Mr. Moon had already said. He could say this, that, during the year the plant had been installed at Wareham, it had been of the greatest possible advantage to them. They had two stokers, who were formerly agricultural labourers, and they had a manager who five years ago was a painter. Between them, they ran the plant with complete success. There was no trouble at all. It was a plant anyone could run; and he was bound to say it was a plant that could be installed by many other works a great deal larger than those at Wareham. He was recently at a small works where there was a sulphate plant—a plant which made a ¼ ton a day; and he then referred to the amount of labour that was being employed. He was again at the works only a week or so ago; and he tested the effluent liquor. He found the Twaddel in the saturators ran up to 63°; and the man was fishing horrible looking salt. On calling attention to this, the explanation was that he (Mr. Woodall) had complained that there was too much labour in the yard, and so this man had been employed turning over oxide. Through this, he had forgotten to put in the lime, and to look after the saturator. It was a gas-works making upwards of 15 million cubic feet a year. He (Mr. Woodall) was sure such a works would be much better off with a simple sulphate apparatus than they were with an old-time, though accepted, form of plant. The plant that had been described was a nice looking plant, and one that was up-to-date for small works. It was one that was worthy of consideration by companies of quite considerable outputs, as well as by very small companies such as Wareham.

Mr. A. E. Broadberry (Tottenham) said he should like to thank Mr. Moon for contributing this paper, which, he was sure, all the members had found most interesting. Certainly the information would be very useful in the future. There was one thing he should like to say in connection with it. Mr. Moon spoke of the process as being a novel one. But it was really a matter of history repeating itself, because he (Mr. Broadberry) remembered well, when he first went to the Tottenham Gas-Works, there were two old vessels there which had been used by Mr. Alexander Croll, when he ran the Tottenham works in the years from about 1845 to 1848. He manufactured sulphate of ammonia in very much the same way. He (Mr. Broadberry) had looked up the first volume of "King's Treatise," published in 1878; and he found there (p. 395) a reference to Mr. Alexander Croll's patents for the purification of gas in 1840: It said: "The sulphuric acid process for the removal of ammonia was in operation for some years, and answered most successfully. The claim was for the gradual addition of sulphuric acid to water, so as to maintain the solution with an excess of acid of from 2 to 3 oz. per gallon of liquid. This had no injurious effect on the illuminating power of the gas; and the liquor was run off just below the crystallizing point. It was then boiled down; and a very fine, white sulphate of ammonia was obtained." This was a matter of over half-a-century ago. The legends which existed at the works when he



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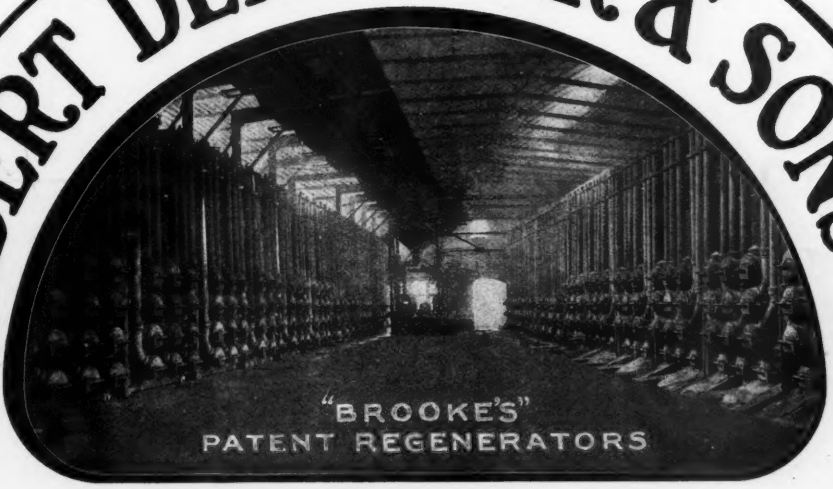

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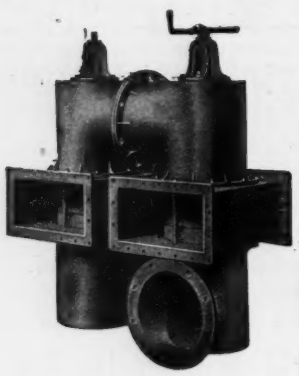

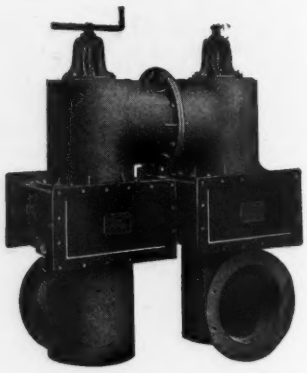

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first went there hardly confirmed the last statement about a fine, white salt being obtained. What he heard about it then was that the process was given up because the sulphate of ammonia came out like a lot of black sludge. But this process was worked many years ago; and the probability was that they did not take the trouble to properly filter the solution of sulphate of ammonia in the way Mr. Moon suggested; and very likely this was the cause of the salt being so dirty, as legend reported. He thought that perhaps the information that such a process had been at work in the past would be of interest to the meeting.

Mr. Moon, in reply, thanked the members for the kindly way in which they had taken his small effort. In regard to the Chairman's request for the cost of the plant, he was afraid he could only give the cost of the small plant that they had installed at Wareham. It was £50. As to the Dunstable plant, he had no particulars. Then a further question raised by the Chairman was as to the possibility of operating the plant in works without an exhauster. He took it the question in Mr. Head's mind was that of back-pressure. The back-pressure thrown by the plant at Wareham was 1 inch only, and it could be reduced to ¾ inch quite easily; and he thought ¾ or 1 inch could be quite easily added to the pressure of a country works. The disadvantages of the back-pressure would be more than compensated by the clean gas that was obtained. He appreciated Dr. Colman's remarks with regard to the possible effect of a neutral gas upon oxide of iron. So far as their present limited experience went at Wareham, they had not found any difficulty in this respect. If they did, they would certainly bear in mind Dr. Colman's suggestion to bye-pass a tiny stream of gas so as to get a small amount of free ammonia in the washers. It had been most interesting to hear Mr. Broadberry's extract from "King's Treatise." It was to all intents and purposes a brief summary of the plant he (Mr. Moon) had described that day, and most unwisely in the paper called a "novel" plant. What he really meant, and had in mind, was the fact that at the present time it was not in use in ordinary gas-works. With regard to the dirty sulphate legend at Tottenham, it was possibly due to the lack of attention with regard to the extraction of tar. If tarry vapour were formed, the acid precipitated certain hydrocarbons, and this had a deleterious effect upon the sulphate. It was to remove these dirty hydrocarbons that careful filtering was necessary. Mr. Phillips had kindly intimated that he or Mr. Wilton would be pleased to see at Dunstable anyone interested in the plant.

DISTRICT PRESSURE.

By Thomas Price, of Walton-on-Thames.

[A Paper read before the Southern District Association of Gas Engineers and Managers, Nov. 10.]

It is not the writer's intention in this short paper to introduce anything new in the direction of distribution practice, but rather to put forward some of the difficulties to be met with at the present time, with a view to promote a discussion that may be helpful to himself and others.

The time is now long past when it was thought to be the best policy to keep down the pressure in the distributing mains to the lowest point consistent with the possibility of providing sufficient to give a fairly shapely flame to a flat-flame burner. But it is well within the memory of most when a pressure of one inch at the consumers' burners was considered to be the ideal, and gas-stove makers designed their apparatus and rated the consumption at this pressure. The very rapid extension of the use of gas heating and cooking stoves after a time demanded that an increase should be made in the day pressure. It was feared that this increase would have the effect of increasing the leakage from the mains and services; but an examination of the returns of gas undertakings since higher day pressure has been given has proved this fear to have been groundless—in fact, the writer's experience with his own Company has been quite the reverse; for coincident with the greater pressure given there has been an actual decrease in the gas unaccounted for.

It may be that this is partly due to the fact that more careful and systematic supervision and testing of consumers' meters have been organized, and are producing the desired effect. But it has also occurred to the writer that the higher pressure during the day time has led to the discovery of leaks which would not otherwise have been detected. Again, an increase in pressure was found to be necessary to give a proper and steady supply to incandescent burners, which, in a comparatively short space of time, have almost completely superseded other forms of gas lighting. Adequate pressure is without doubt absolutely necessary for the production of the maximum light with these burners, especially with those of the inverted type.

The demand for higher pressures which have been found necessary for the proper working of burners and gas-stoves, as the writer has here attempted to outline, has led to the maximum available constant pressure as given by the gasholders being utilized. The word "constant" is here used to signify the pressure that may be given by the lightest uncupped holder, as it is recognized that it would be useless to depend upon the extra weight of a holder when cupped, if it should cause a sudden fall of (say) 3 inches at the time of greatest demand by incupping, as this would cause inconvenience to consumers and result in numerous complaints. In order therefore to increase this initial pressure, the writer is introducing a pressure-raiser of the fan type to get over the difficulty and to utilize the whole of the storage capacity. As this apparatus is not yet installed, he is not in a position to say anything from his own experience as to its utility; but as it has been for some time successfully used in many works, he has little doubt that it will fulfil his requirements.

It is claimed that by this means the enlargement of existing mains otherwise necessary may be in many cases postponed; but inasmuch as the principal extensions taking place in a district usually occur upon the outskirts, it has occurred to the writer that great and undesirable fluctuations may follow through raising the initial pressure by any such apparatus. Even at the present time, and under existing conditions, there are very wide variations in pressure occurring owing to the constantly changing demands. An instance of this was particularly noticeable when the writer was recently experimenting with an automatic pressure operated lamplighter. This instrument, after working admirably at no great distance from the works, when fixed three miles away (having operated to light at the predetermined time) was extinguished unintentionally about an hour afterwards by the pressure reducing owing to the consumption increasing, and again rising as the consumption fell off. After the pressure had been reduced at the works to the minimum for the night, and the consumption had still further dropped to practically *nil*, the pressure crept up, and the lamp again lighted. Of course, this was due to the local conditions of that particular part of the district, size of main, attitude, and consumption; but the conditions were not such as to call for an enlargement of the main—it being found, upon taking a chart, that the pressure had not dropped below 25·10ths during the evening.

The point upon which elucidation is required is: What is the range of variation in pressure within which it is advisable to keep, in view of present-day methods of consuming gas, in order to give satisfaction to consumers and to maintain the superiority of incandescent gas light over other means of illumination for quality and steadiness, and the best method of maintaining it within that range? Now, with inverted incandescent burners and gas-fires which have nicely regulated gas and air adjusters, a very uniform pressure is necessary to ensure their perfect working, and nothing is more annoying to consumers than to find a burner at one time making a popping and spluttering sound, and, after having carefully adjusted the same, to find later in the evening a readjustment necessary owing to a falling off of the pressure.

It would appear that an ideal state of things would be such that would give as nearly as possible a straight line on the pressure chart at all times during the twenty-four hours; but this would entail with many of us an enormous expenditure in enlarging and rearranging the mains; and the writer is not acquainted with any district in which such a state of things exists. It is not so much that it is desirable to keep the pressure down to a point which may be considered sufficient for all purposes, as that, whether kept moderately low or high, there should not be very wide variations.

In a certain road in the writer's district, where there are a number of workmen's dwellings, it was found that numerous complaints were being received of insufficient pressure for cooking purposes on Sundays. It was stated that when the ovens were first lighted there was quite enough gas for the purpose, but that before long the gas went down, and the result was that when the time came for dishing-up, the dinner was but half-cooked. Now, in order to meet the demands of the slot consumers, who, as a rule, take the advantage of having a hot midday meal on perhaps the only day on which they are all at home, it has been the custom to raise the pressure at the works from 20·10ths to 35·10ths at from 11 to 11.30 in the morning. A chart of the pressure taken at one of these houses revealed the fact that about 30·10ths were recorded when the increase was first made; but this gradually fell to 18·10ths as the number of people using their cookers increased. This lower pressure should, of course, have been sufficient to cook successfully; but as the taps had been adjusted when it was at 30·10ths, there was not sufficient gas at 18·10ths without further adjustment, and this the consumers in question failed to make.

Seeing that it is practically an impossibility to regulate the pressure to that most suitable to every consumer by means of station governors, and to maintain it at that pressure at all times, it has occurred to the writer that the point at which this should be done most effectually would be at the consumers' meters. He does not claim that there is anything novel in this proposal; but it has certainly not come into universal practice. If a thoroughly reliable governor can be found that is not too bulky or too expensive, and it be fixed with every meter, it is the writer's opinion that its adoption would amply repay the outlay. By preventing the fluctuations and variations that now occur, and thus giving a steadiness to the lights and lessening the waste of gas from the use of improperly regulated gas-stoves, or other apparatus that may be in use, the insurance of the best results would obtain, and confidence and contentment of consumers follow.

Discussion.

The Chairman (Mr. H. C. Head, of Winchester) said he was sure the members would all think Mr. Price's paper a timely one from many points of view. To begin with, at this time of the year, most of them were looking round their districts in search

of weak spots, where new mains were required. Another point was that the pressure of a district wanted to be as constant as possible, both with regard to time and place. They did not want to have 6 inches in one part of the district and only 1 inch in another; and they did not want to have 6 inches in a house at one time and only 1 inch at another. With a varying gas pressure, no consumer would be happy. With reference to the suggestion as to governors to each service, a point that had a bearing on this was that they had not got them at present; and they had rather to mend existing conditions, and leave ideal conditions to later on. He thought much could be done in regard to district pressures by taking the average pressure at some representative part a distance from the works, and trying to keep this as constant as possible. If a drop of 1-10th was found at any time, then 1-10th could be added at the governor.

Mr. W. B. Farquhar (Ilford) said that fortunately in his district they had mains of sufficient size, so that they could give 3 inches pressure at the works, and get it all over the district. But where a district was under-mained, it was impossible to regulate with one governor at the works so that one could get a straight pressure line throughout the district. He was struck with one part of the paper. The writer spoke about 20-10ths pressure. This appeared to him (Mr. Farquhar) to be a low pressure to which to work. In his district the pressure was 3 inches; and they went up to 4½ inches. A number of years ago, they used to regulate the governor in the morning to meet the cooking hours. They then took the pressure off again; put on more pressure at dinner time, then took it off again; and then put more on again in the evening. He was now working with a view to getting a constant pressure right through. He started at five o'clock in the morning with 4½ inches pressure, and kept this steadily throughout, until about twelve o'clock at midnight, when the pressure was changed to 3 inches until five o'clock in the morning, when it was again 4½ inches. There was an advantage in this to the gas-works. The fitters could go out during the day to fix gas-fires and adjust burners at the pressure at which they were going to be used. If they adjusted them to only a pressure of 3 inches, when the night pressure was put on there was trouble. The burners were not regulated to the increased pressure. Now they could during the day adjust the burners precisely to the pressure conditions under which they were going to be used in the evening. A reference had been made to governors on the meter. If he remembered rightly, Messrs. Milne and Sons made a meter called Macfie's patent governor meter, in which there was fixed (inside) a small regulating governor, which could be adjusted to suit any pressure that the meter might be put under. A fitter could regulate the pressure to any given point; and, of course, it would remain at that. He had had no experience with these meters, and so could not say whether or not they were of real utility. He had had a pressure-chart taken two or three days ago, to verify the pressure on his district; and he found the charts at two or three points at the extreme end of the district showed practically a uniform line with the pressure given in the works. But he recognized that this was a very fortunate position to be in.

Mr. J. H. Cornish (Bridgwater) remarked that it seemed to him the writer of the paper had almost entirely struck the conditions under which they suffered in his own case a few years ago. Their main supply was drawn from a holder which was large in diameter, but shallow in depth, and only gave, on a dropping pressure, something like 28-10ths. Every member would realize that this was not much good in these days of inverted burners, gas-stoves, engines, and what not. He made inquiries—and he believed he got his ideas from Bournemouth—as to the best means of overcoming the difficulty. He was struck with the simplicity of the Sturtevant fans, coupled to De Laval turbines. It seemed to be a simple apparatus, and inexpensive. He procured a set, and installed it; but as soon as he started to make his connections, he found he had a nice combination of circumstances. He found that the main by which he was drawing gas out of the big holder, and forcing it into the town main (it was a 12-inch one) was a common main running between the two holders; and the outlet to the town governors was taken off between the two. Of course, as soon as he began to draw out of the 28-10ths holder, he started to at once fill the telescopic holder on the other side, and this gave him 6½ inches pressure, which for a small district like theirs was sufficient for the present time. He conceived the idea of stopping this holder—not allowing it to go above a certain point. What he did was to simply put a cantilever on the top, and this was effectual. It was certainly necessary to control the governor of the De Laval turbine, because driving at a speed of something like 16,000 revolutions per minute, and the fan at 4000 revolutions, it gave them 13 inches pressure; and 13 inches pressure on a small holder would tend to blow the cups. Putting a weaker spring in the governor, he found it quite easy to reduce the speed one-half, and he got the 6½ inches pressure which the telescopic holder gave. This had now gone on for something like three years; and it was the most effectual apparatus he had ever seen in a gas-works. It ran beautifully; and the quantity of gas required from it did not make the slightest difference. The holder on the other side was kept full of gas, and acted as a buffer or like a gas-bag; and it kept up the supply on the inlet of the governors at 6½ inches pressure, and enabled them to distribute at 40-10ths pressure, which was maintained during the lighting hours over the evening. If Mr. Price met with the same success as they had done at Bridgwater, he would be delighted with the apparatus as he (Mr. Cornish) had been.

Mr. W. D. Child (Romford) remarked that Mr. Price in the early part of the paper stated that, since raising the pressure for his day consumption, he had actually had a decrease in the quantity of gas unaccounted for. In order that Mr. Price might make his paper perfectly clear, he should like to ask him whether this was really a decrease in the quantity of the gas unaccounted for, or whether it was a decrease in percentage, owing to the increased quantity of gas sold for cooking and heating purposes in the day time.

Mr. Price: It is an actual decrease in quantity.

Mr. Child (proceeding) said that Mr. Price also stated that he was putting down a fan for boosting up the pressure in his district. Owing to the temporary disablement of a holder, he (Mr. Child) had been compelled to adopt some means for raising the pressure in an outlying district; and had found it inconvenient and difficult to maintain an even pressure, owing to the varying consumption in the district. Sometimes the pressure would be very high, and then it would fall again. It had occurred to him whether a desirable effect might not be obtained by boosting up to a high initial pressure on the inlet of the governor, and so enable one to send out the gas at any pressure that might for the time be desired.

Mr. W. E. Price (Hampton Wick) observed that the condition of affairs described by Mr. Farquhar must be considered as ideal, and not as a condition that would be met with in the majority of cases—at any rate, not in the districts controlled by members represented at the meeting. He thought they would have to almost generally look at a condition of affairs similar to that described by the author in the paper. Then it came to the question as to what was the best thing to do in the circumstances. The question of boosting seemed to him, at any rate, to be all right when it was a case of mains being too small, and it was desired to get a larger amount of gas to a weak spot. This appeared to be the cheapest way of doing it in these days. Of course, the alternative was the relaying of mains. The point that appealed to him most strongly was that of the variation of pressure—not so much the question of not having sufficient pressure, but the variation that was bound to occur in the ordinary canalization in the district. When he said "ordinary," he meant as distinguished from the condition described by Mr. Farquhar. He (Mr. Price) naturally supposed they all more or less used a pressure-register, and kept a chart of the different parts of their district, and so found out their weak spots. Having done this, they had then to set about trying to draw up a programme of pressure increases or decreases (as the case might be) at the district governor, and endeavour to keep a constant pressure at the spots at which they had found the variations. So far so good. But they had only succeeded in keeping this constant pressure at the one spot, after all, from the works. But the pressure varied most near the works and least nearest to the spot which was the most difficult one to supply. So, after all, having done this, they still had the trouble of the consumers' complaints as to variations of pressure—variations which were noticeable with incandescent burners. He was speaking of what he had himself tried, and had attempted to overcome. But there was no satisfaction in it after all, because the district which was nearest the works was still having varying pressure, and only a small portion of the district was getting constant pressure; and anywhere between these two points there was a variation more or less. Therefore this brought them back to the use of governors. Of course, he was now assuming the mains were not large enough to give constant pressure. He had come to the conclusion that there was only one way in which they could give constant pressure, and that was by having governors fixed in each house. It was a question of cost; but it was also a question of convenience. He did not see how the control of the pressure from the works could overcome all their difficulty; and he was bound to say the only way he could see out of it was the use of governors.

Mr. D. H. Helps (Reading) thought the last speaker had raised the most important point in this matter—the variation of pressure that was taking place between the works and the confines of the district. He had himself been looking into this matter during the last twelve months in a part of his district where the pressure was lower than in any other part of the outlying area. One could improve matters in these outlying districts by boosting at the works; but it did not get over the question of varying pressure through the arteries and larger mains. One could introduce a high-pressure main in the outlying district, but that was a very expensive way. If one had to boost, the best thing to do was to see that the fall in pressure throughout the area was equal in every direction. If there was some particular spot where the pressure was very low, it would be better, before adopting boosting, to enlarge the mains on the line, and then they would not have to boost unnecessarily high at the works to raise the pressure at this particular point. He quite agreed with Mr. Price that it was desirable they should use consumers' governors, if they could find a small reliable one.

Mr. F. W. Cross (Lea Bridge) said that one or two of the speakers had gone from the point that Mr. Price wished to make—that was, that the boosting was done on the inlet of the governor. He took it that this was what Mr. Price was referring to; whereas most of the remarks made alluded to the boosting of the gas on to the district. He (Mr. Cross) was now putting down plant for boosting direct on to the governor; but as the plant was only just being erected, he would not pretend to say anything on the subject. Was there not, he asked, some mistake in the

paragraph of the paper where it was said the author's plan on Sundays, in giving sufficient pressure for cooking, was to put on increased pressure—from 20-10ths to 35-10ths—from 11 to 11.30? Was not the latter figure a misprint for 1.30?

Mr. PRICE explained that between 11 and 11.30 was the time when the increased pressure was put on, and not merely the duration of the supply at the higher pressure.

Mr. A. E. BROADBERRY (Tottenham) said there were one or two points that he might make, which perhaps would be interesting to the members, in regard to the question of boosting. Mr. Price suggested that it was sometimes claimed that this would save the expenditure of a great deal of money in laying new mains; but he seemed to fear that saving of money on mains in this way might lead to a great many variations in pressure. But if the work was carefully carried out, he (Mr. Broadberry) did not think Mr. Price need have any fear on this score. Since 1902, they had been boosting on to the inlet of the governors, and cutting down from the governors according to what was required in the district. But at the time they introduced the system, they isolated the leading mains from the works right out to the centre of the district—to the more populous places. Their works were situated on the margin of the area of supply; and the mains were connected from the central points, and gradually led back to the outskirts of the district, and, among other directions, in that where the works were situated. By isolating the leading mains out as far as the central parts, and by running just a few feeding-mains to other important centres lying a little away from the actual trunk main itself, they had succeeded in establishing fairly even pressures all over the district, and they were able to keep the pressures on the margin all round fairly even. From the fact that some of the district mains led back to just outside the works, a pipe was carried from these mains (which were small on the margin of the district) into the governor-house; and they worked according to the pressure on these marginal mains, although they varied the pressure on the governors themselves. This did not affect the consumers lying between the works and the central portions of the district, because the mains were untapped up to this point. He thought that if Mr. Price could add such a system as this to the boosting plant he was now putting in, he would find it very beneficial. With regard to inadequate mains when using automatic lighters and extinguishers, he (Mr. Broadberry) had had a good deal of experience in this connection; and he had come to the conclusion that these were the finest indicators they could have of the insufficiency of their mains. Of course, he did not know what sort of lighter it was that Mr. Price was using; but he imagined it was one that worked on just the differential pressures, and did not get the full pressures, and had no margin between the high operating point and the low operating point. As to house governors, he thought their use would undoubtedly afford satisfaction to the consumers by giving them a very level gauge. But in such a case as Mr. Price had mentioned, where in one street the consumers could not get enough gas on Sunday morning for their cooking purposes, the employment of a house governor was not going to give them sufficient pressure to do their cooking, nor was the lack of sufficient heat to do the cooking merely dependent, as Mr. Price seemed to assume, on the bad adjustment of the burners. He (Mr. Broadberry) had tried experiments with ordinary atmospheric burners in the boiling of a given quantity of water, or raising it a given number of degrees with all sorts of adjustments of air; and it made practically no difference at all, so long as they did not get a steady flame, as to the consumption of gas per unit of heat obtained, whatever the air adjustment might be.

Mr. P. P. CHANNON (Haywards Heath) said the author's main point was that they should maintain even pressures; but the discussion seemed to be wandering away from that. Mention had been made of the method of obtaining uniform pressures at the consumers' meters by using governors on the outlet of the meters; and it seemed to him (Mr. Channon) that this was certainly the most satisfactory way they had of giving their consumers equal pressures at the present time, as their system of mains was of necessity imperfect. But there had been remark made on the fact that, though one maintained equal pressures at the works, one would get varying pressures over different parts of the district, owing to the inadequacy of the mains. Now if equal pressure was maintained on the outlet of the consumers' meters, they would still get varying pressures over different parts of a house, owing to the inadequacy of the pipes. He had known such instances as a big gas-pipe put to a ½-inch pipe, and twenty or thirty burners taken off it. Would it not be better to control the pressure at the point of ignition, or as near thereto as possible—that was, at the burners themselves? In the latter days of flat-flames, nearly all governor burners were used; and they worked fairly efficiently. Was it not possible to get governors capable of attachment to "C" and inverted gas-burners, and small governors for cooking-stoves and gas-fires as well? He could not help thinking this would be a better and cheaper way of giving an equal pressure at the point of combustion, and so affording satisfaction. One other point. He had found that gas-fitters, in putting a governor on the outlet of the meter (it might be a very efficient governor) sometimes forgot to regulate it to the minimum pressure ever given at the meter. They put it at something above the minimum pressure, and when the minimum was given, there was trouble.

Mr. CHARLES CARPENTER said it was not an easy matter to contribute any remarks on this paper, because the subject was so wide and important. He was perfectly certain that the time given to a paper of this kind, which dealt with such a vital part of their industry, would give them better value than any discussion on abstruse chemical matters with regard to the direct conversion of sulphuretted hydrogen to sulphuric acid. This question overshadowed enormously comparatively small, though interesting, chemical questions. With regard to the paper, he was extremely sympathetic with the author's views. The ideal condition in gas supply, was to give a uniform pressure to every consumer at his meter. The only other course was the one mentioned by the last speaker. But, having experimented for several years on the subject, he (Mr. Carpenter) found there were considerable difficulties to be surmounted before producing, on a commercial scale, a governor that wou'd control, under all the conditions of working, incandescent burners which were now the vogue. And one of the reasons was that a more accurate adjustment was required, now that the quantity of gas flowing through a burner was much smaller than it used to be. With the flat-flame gas-burner, the consumption was never less than 5 cubic feet an hour; but now the burner that had become most popular—at any rate in London—for indoor lighting was a small size one, burning 1½ to 2 cubic feet of gas an hour. When one got down to these small quantities, the difficulty of a governor attached to a burner increased very considerably. He had, therefore, reluctantly come to the conclusion that what would be done on the large scale before many years passed, would be in the application of governors to the consumers' services. He had reluctantly come to this conclusion, because it was clear to anyone who had considered the matter that the expense of doing this would be considerable. One of the members had spoken of a level line of 4½ inches from five o'clock in the morning till midnight, and 3 inches from midnight to the morning. If they all had conditions such as these, they would not want consumers' governors at all. But his own conditions in South London were different from those. Mr. Farquhar's memory was quite clear when he said that Messrs. Milne and Sons made a meter with a regulator attached. It was a dry meter with a single valve. In South London, though they had several thousand governors in use, the number was rapidly increasing. The governor they used had a double valve, which gave most accurate results. It would take some time before they got this state of things generally existing. Meanwhile, they had had to do something else. As had been pointed out, the incandescent burner (and especially the inverted burner) was more sensitive than other form of burner to variations in pressure. They had therefore been engaged in investigating the physical problems—they were many, and most interesting—appertaining to inverted burners. They had now got one (which they were introducing this coming season) which complied with the condition laid down of a minimum pressure of 2 inches and a maximum pressure of about 4 inches. Under these conditions, the burner gave good results. But this was the intermediate step towards the realization of what he thought would be the proper condition of affairs—that was, a level pressure line for every consumer. There would be other advantages in this than for lighting. There was the question of cooking. It was much easier to cook one's food properly if one knew exactly what pressure was going to be obtained at the stove, and how much gas would be burnt in an hour. Cooking by gas was ideal with the conditions uniform. He thought they could obtain what was required perfectly well with a piece of leather as a diaphragm and a piece of spring between the valve and the diaphragm. By such simple means, they would be able to produce a level line, and enable cooking (which was an increasing portion of their business) to be done in a correct manner. A cook ought to know exactly the time it should take to do a certain amount of work all the year round. With regard to boosting, there was no difficulty in giving any increase of pressure that might be desired. The inner lifts of many gasholders were not high enough for the requirements as regards pressure. But it could be easily done by boosting—and this on the inlet of the governors. There was no difficulty with regard to doing this on the outlet of the holders; and it was really better to do it this way, and rely upon that beautiful piece of apparatus, the automatic governor, to control it. He thought it better to do it in this manner than attempt to bye-pass the governor, and put the pressures on the leading mains. Not every manager of works was in the same position as Mr. Broadberry. But where it could be done, it made the work extremely easy—that was, with a back gas pressure, so to speak, the pressure on the confines of the district far removed from the governor was brought back to the governor-house. Connected up to a gauge (as he fancied was done in Mr. Broadberry's case), they had a given pressure on certain predetermined lines that would give the pressure to exactly that which was needed to meet the requirements of the district. In South London, they had from 100 to 200 automatic pressure recorders for plotting out pressures on the district. They were the only means by which an engineer could satisfy himself that any consumer was getting his full supply of gas. These recorders were most easily applied—being simply hung on to the pitching-iron of the lamp-column; and there they could get a register of the pressure at any time they pleased. The author of the paper had tackled a difficult problem, and a very important one. He (Mr. Carpenter) felt sure the conclusions, in the main, were the right ones and those which would have to guide them largely in their future practice.

Mr. PRICE, in replying to the discussion, said with regard to the

President's remark about giving constant pressure at one point, this was what, as a matter of fact, they did in his own case; but the point happened to be the gas-works, which were just about centrally situated in the district. The district ran practically three miles in every direction. Of course, if they took any point, and determined to maintain a given pressure there, a variation occurred between the works and the point. Mr. Farquhar said he was giving from 3 to 4½ inches pressure; in his own case, they were giving from 2 to 3½ inches at the present time. But he was hoping to go to a higher pressure when the booster was in operation. The reason the minimum was put at present at 2 inches was because the upper lift of a light holder only gave this pressure; and it was useful sometimes to be able to work out the lift. He was very much obliged to the members for the way they had taken the paper; and the hints they had given. Of course, his intention was, when the booster was in operation, to give a much higher pressure with a reliable governor—giving a much higher pressure at the inlet of the station governor, and also a very much higher one on the district mains. He did not see why they should not give 5 or 6 inches, or 10 inches if preferred, providing there were proper governors at consumers' houses. Of course, with the pressures that had hitherto been given—perhaps 1½ or 2 inches—governors were very unsatisfactory in the consumers' houses, owing to the small pipes that were usually found in them. Under these circumstances, they might get sufficient pressure in one room, but not in another. If they gave 5 or 6 inches pressure at the inlet of the consumer's governor on his service, setting the governor to give as much as was being afforded now without a governor, or 3 or 4 inches if preferred, there would then be sufficient pressure to supply all the requirements of the house.

HIGH-PRESSURE LIGHTING.

By A. E. Broadberry, Assoc.M.Inst.C.E., of Tottenham.

[A Paper read before the Southern District Association of Gas Engineers and Managers, Nov. 10, 1910.]

On being asked to supply a paper for this meeting, it occurred to the writer that a discussion on the subject of high-pressure gas supply would be welcome at the present time, when the various high-pressure systems are doing such great work in maintaining the position of gas lighting far in advance of all rivals.

In the following remarks it is not proposed to draw any comparisons between the several excellent systems now before the public, but rather to describe the successful installations of outside shop lighting carried out on a joint principle for the benefit of the various shopping centres which have in the past two years been inaugurated by the Tottenham and Edmonton Gas Company, and place facts and figures before the members of the Association, in order that those who have not already adopted similar arrangements may be able to judge of its advantages, and so that those who are doing similarly may add their testimony to the mutual benefits which follow its adoption. The writer has no claim to be the first to promote such a scheme, and does not doubt there are other cases where an even better success has been obtained; and he is hopeful that, in placing his case before the Association, he may gain for himself and other members some assistance and advice in further improving the position of gas as the best lighting agent for almost all purposes.

Progressive Pressures.

The term "high pressure" as applied to gas supply is a comparative term only. The science of gas supply is advancing so rapidly, and the conditions change so completely from year to year, that standards are no sooner set up than they may become obsolete. With the introduction of the incandescent mantle, pressure at once became a matter of great importance, and although at first an inch of water pressure was spoken of as the standard for the Welsbach light, it soon became evident that better results were obtained at higher pressures. Conditions again changed when the inverted burners were introduced. With this type of burner, good pressure is so essential that, in the writer's opinion, any gas engineer who permits the pressure in any part of his district to fall below 3 inches water pressure during the ordinary lighting hours is doing an injustice to himself, to his company or council, to his consumers, and, above and beyond all, to the industry that he serves. The author asserts that gas would much more readily maintain its easy lead in the matter of artificial lighting if more strict attention were paid to the proper maintenance of district pressures.

In the Tottenham Gas Company's district, a system has been adopted of placing pressure registers in various spots likely to be the worst served; and the shocking results at first shown led to the rectifying of faults which has had most gratifying results. No difficulty has been experienced in finding people who, for a small remuneration, will attend to the simple matter of taking the diagrams and posting them daily to the works. Those gas engineers who have not already adopted this system would do well to do so at once; and some surprising results will be experienced. But the author would like to emphasize that the registers should be placed in absolutely the worst spots, so as to avoid the undignified mistake attributed to the ostrich when in danger. It is hoped that these remarks, though somewhat beside the mark in regard to "high pressure," may not be considered out of place.

When upright burners alone had to be considered, 8 inches water pressure was regarded as "high by Messrs. Keith, Blackman, and Co., who put in many brilliant installations; but the power required for this slight increase was small, and the best suggestion of the firm then was to use a compressor worked by water pressure. This left the success of the gas installation at the mercy of the water company, which was a distinct disadvantage. As an alternative, an electric motor was suggested. But even at the present day electric supply is sometimes known to fail; and the position of gas lighting was very undignified if when the electric lights should chance to suddenly leave a district in darkness, instead of triumphantly shining on, the gas lighting had to acknowledge itself unable to stand alone, notwithstanding all its great reserve of power.

Messrs. William Sugg and Co. came to the rescue with a compressor driven by a gas-heated hot-air engine, which left gas quite secure in depending on itself. It was with one of these plants that the Tottenham Company first began to operate in higher pressures. A tradesman who had been offended with gas lighting on account of his constantly neglecting to clean his lamps and burners, and also to re-mantle the latter, had adopted a well-known incandescent oil-lamp system, which, for some reason, he did not find so satisfactory as he had anticipated. He therefore agreed to put in a Sugg plant four years ago; and the plant is still doing good work and giving every satisfaction to-day.

From this start many similar individual installations were put in, and continue to increase. Meantime, though Sugg's 12-inch water pressure and Keith's 8-inch pressure gave such good results with upright burners, a member of this Association, Mr. Onslow, was engaged in experiments on far higher pressures, and proved beyond doubt that at 40 inches water pressure he could obtain still better results; and several fine installations of factory lighting were introduced. Then came the startling results of 67 candles per cubic foot realized by the Keith inverted regenerative incandescent lamp.

Parade Lighting by High-Pressure Gas.

At the same time, it was becoming evident that tradesmen who had not adopted, and were not prepared to adopt, individual installations of high pressure, were being placed at a disadvantage; and it was decided to propose a joint lighting scheme for Green Lanes, Harringay (a most important shopping centre), on the lines previously adopted at Ilford, and called "parade lighting." After seeking advice from Mr. Farquhar of that town, a circular emphasizing the fact that "trade follows good lighting" was sent to a row of imposing shops known as "Grand Parade," suggesting a joint scheme, whereby each lamp should be supplied free of charge by the Gas Company, fixed, kept clean, lighted, extinguished, mantled, and supplied with high-pressure gas for an average of three hours per day, at an inclusive charge of £1 per quarter, which was to be the sole expense which the customer must meet.

The proposal was left as free and untrammelled as possible; but a minimum of fifty lamps for one year certain was asked for as a start. As tradesmen on the opposite side of the road asked to be admitted to the scheme, the fifty were soon obtained, and the supply commenced December, 1908. The estimate in the report to the Directors, which induced them to sanction the first installation, showed that with a hundred lamps a margin might be expected of £47 14s. 2d.; and with only fifty lamps, 13s. 4d. A well-founded faith in the proposed system induced them to permit the experiment.

The installation consisted of two (afterwards three) "A" type rotary compressors, fitted with a continuous lubricating device, and direct coupled to ¾ H.P. Gardner gas-engines. The lamps (600-candle power Keith-Blackman burners in 1000-candle power bodies) were fitted with Keith's distant lighters. The lamps and lighters may be best described in the makers' own words.

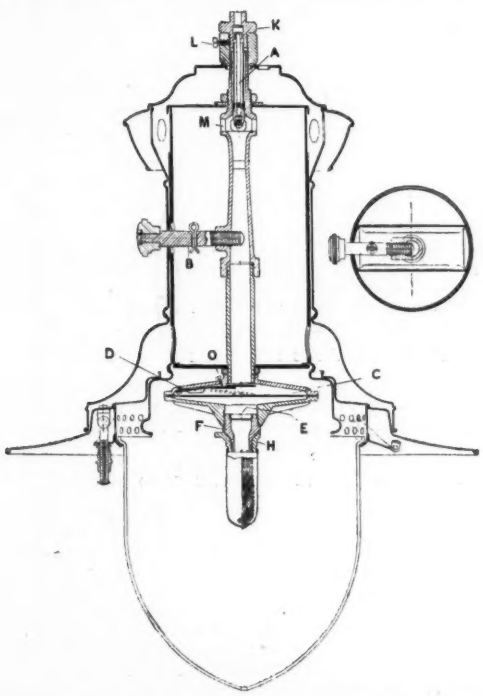
Keith Inverted High-Pressure Lamps.

As will be seen from the illustrations, the body of the lamp is double cased, which greatly increases the durability of the lamp for outside use. The outer globe is dropped into a hinged gallery, from which it can be readily removed. The wire protection for the outer globe is attached in a simple way to the gallery, permitting removal if necessary. The globe can be readily lifted out of the gallery, leaving the wiring in position, which facilitates cleaning without risk of damaging the wire. The lamp is suspended from a connection K, to which is attached a tube A, which carries the gas-nipple, and also contains an efficient dust-trap. By unscrewing the lamp bodily from the connection K, first slackening the set screw L, this nipple can be readily examined or adjusted to suit the gas, without breaking any gas-joint or taking the lamp to pieces. The lamps can be arranged, when specially ordered, with a stirrup piece on the top, which permits of the nipple being withdrawn without taking down the lamp.

The air adjustment B consists of a screwed plug with a porcelain head projecting through the casing. The inner end of the plug passes into the bore of the burner, and by more or less obstructing the flow of the mixture, according to its position, regulates the amount of air that is drawn in at the openings M. The heater C is fixed on the bottom of the burner-tube, and takes the form of two shallow cones fixed base to base, with a diaphragm between perforated at the outer edges, which has the effect of spreading out the mixture of gas and air over a large area of highly-heated surface before reaching the nozzle F. Access to the gauze E is obtained by unscrewing the nozzle F. It will be found in practice that, under ordinary circumstances, it is not necessary to clean this gauze regularly, as in the case of our upright burners, as the

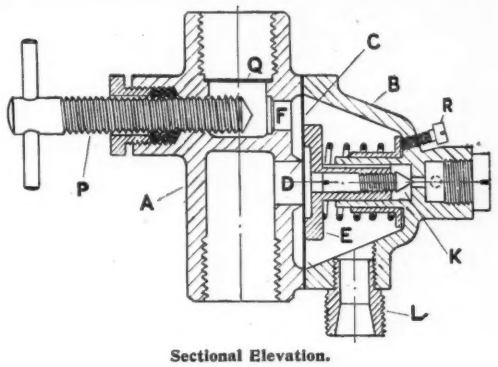
The Tottenham Gas Company's Head Offices at Night.

high velocity of the mixture through the gauze tends to keep it clean. Whenever the mantle is renewed, however, it is advisable to examine the gauze, in case it may have accidentally burnt through owing to the lamp lighting back. Care should be taken to see that the new gauze fits snugly into position.

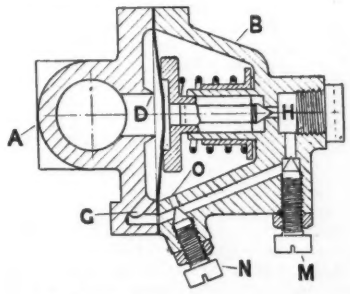


The nozzle F is threaded on the outside; and on this the mantle-ring H is screwed. In the 1500-candle power and 1000-candle power heaters, an arrangement D, termed the thermostat, is fixed. This consists of a compound strip of brass and a special alloy of low expansibility, with the brass uppermost, one end of which is attached to the outer edge of the heater. On the other end a disc is fixed, which normally tends to close the inlet to the heater. The small screw O is adjusted to prevent the disc closing the aperture entirely. As the heater warms up, the strip bends away from the opening, owing to the brass expanding at a greater rate than the special alloy.

The effect of the thermostat is to check the amount of air in the mixture when the lamp is cold, by putting in a resistance which is automatically reduced as the lamp heats up. The object of this is two-fold—first, to ensure the lamp lighting up quietly, and thus preventing damage to the mantle; secondly, to simplify the making of the mantle on the burner itself from the soft state. The action of the thermostat is simple and positive, and when once properly adjusted cannot get out of order. In the lamps as sent out, the thermostat is



Sectional Elevation.



Sectional Plan.

adjusted for giving a very poor mixture when first lighted up, so that for a minute or so after first lighting there is little or no light. If it is desirable that the lamp should light up quickly, the thermostat can readily be adjusted by means of the small screw O already referred to. If this is screwed inward slightly, it will increase the opening when the lamp is cold. It is necessary to remove the heater from the lamp to adjust the screw O.

High-Pressure Parade Lighting in the Main Thoroughfare at Wood Green (Keith Lamps).

Lighters.

As will be seen from the illustration, the apparatus consists mainly of a valve body A and a cover B, between which is held a thin metallic diaphragm C. This diaphragm C is made of pure silver, which has been found the most satisfactory material for the purpose, as it does not readily corrode, and does not flake with heat. The valve-seat D is formed in the body A; so that the centre of the diaphragm bears upon it. The diaphragm is held normally on to the seat D by a plunger E, which is actuated by a spiral spring. The gas enters the annular space between the diaphragm and the valve-seat by the passage F, and so long as the gas pressure is insufficient to overcome the resistance of the plunger E, no gas will pass to the outlet. When the high pressure comes on, however, the diaphragm and plunger are forced back to the position shown in plan, allowing the gas to flow through the valve-seat D to the outlet. When the pressure is reduced again, the diaphragm closes by the action of the plunger, and the gas is again cut off.

It will be obvious that the pilot light, which it is necessary to use with such an apparatus, must be controlled, as otherwise, if adjusted to a reasonable size under the low pressure, it will increase to an abnormal size when the lamp is alight, which, apart altogether from the waste of gas, is objectionable. The movement of the diaphragm is used to counteract this increase, and at the same time to make use of it to give a temporary flash at the moment of lighting. A small port G is formed, leading from the annular space, which is always open to the gas supply. This port is connected to a corresponding passage, which leads to the back of the cap into the space H. On the end of the plunger E is fixed a small valve K, which shuts against its seat when the diaphragm is in the open position. When the diaphragm is closed, a passage is left through this seat into the interior of the cap B, and thence to the union L, to which the bye-pass is connected.

The regulating screw M is so adjusted as to allow the correct amount of gas to pass under low pressure through the port to the bye-pass. It will be seen that, when the pressure begins to increase, the amount of gas which will pass the regulating screw M is also increased, so that the pilot flame begins to increase. This goes on until the diaphragm opens sufficiently far to press the valve K on to its seat, which cuts off entirely the supply to the bye-pass from this source. In order to allow of the small pilot light being kept burning while the lamp is alight, to avoid the pilot tube becoming filled with air, and to ensure the pilot being alight when the lamp is turned off, a second adjusting screw N is provided which controls a small port O leading directly into the cap B. This is so adjusted that the amount of gas which will pass through the port O at high pressure is just sufficient to give a small light on the pilot. In order to ensure that the diaphragm C finds its seat accurately on the valve-seat D, a circular depression is made on the face of the plunger E of larger diameter than that of the valve-seat, so that the metal of the diaphragm can accommodate itself to the seat.

In order to be able to shut off the lamp entirely without requiring a separate stop cock, a screw-down valve P is fitted, which is adapted to close the opening F. This works through a stuffing box packed with asbestos cord, and is turned by means of a T handle, so that it can be easily opened or shut by hand. This arrangement enables the cap C to be removed and the diaphragm examined at any time while the pressure is on, without interfering with the remainder of the installation. The gauze Q is fitted on the inlet to prevent any dust or dirt getting into the valve-seat.

Raison d'Etre for the Higher Pressures.

Before passing from the description of the lamp, it is worth considering what are the conditions which require that the gas should be compressed to so great an extent. The explanation is that sufficient force is required to carry the gas and the fullest possible proportion of air through the various parts of the mixing-tube, heater, and burner, and to produce an ideal flame on the mantle. The ideal flame is one that burns fervently but still gently—that is to say, with no undue pressure in itself against the frail mantle. Another condition, in addition to the friction of the parts which the mixture has to overcome, is the tendency of heated air and gas to rise instead of descend as it is required to do, and, further, to provide the velocity at which the mixture must travel to prevent the flame from lighting-back, all of which call for a power greater than could be supplied by low pressure. This power is supplied by the velocity at which the comparatively small quantity of gas is injected through its small nipple into the bunsen chamber by the high pressure behind it. But by the time all its work is performed, there is no unnecessary pressure remaining likely to injure the mantle.

Cast-Iron Pipes for High-Pressure Gas.

The main pipes used on all our high-pressure installations are cast iron, laid almost entirely under the footways. The supplies for each block of shops are run up at the street corners, and carried on top of the facia boards.

Progress of the Shop Lighting Business.

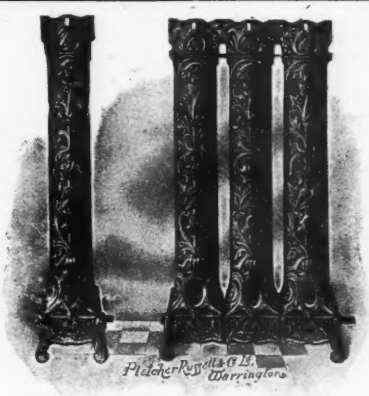
The number of lamps erected at Harringay progressed, in the four quarters of 1909, 52, 61, 61, 71 respectively; and the cost for gas (at full retail price), labour, upkeep, and interest, amounted to £66 7s. 10d., £50 9s. 9d., £54 10s. 7d., and £74 2s. 8d. in the respective quarters. Dividing the cost in each quarter by its number of lamps shows an average of 25s. 6d., 16s. 7d., 17s. 10d., and 20s. for the various periods, or a total of £3 19s. 11d. for the whole year. The first quarter's expenses were high on account of the extra expenses due to initial difficulties.

We had been so encouraged by our success at Harringay, that when another important group of shops about a mile away in the same road (namely, at Southern Wood Green) were prepared to consider a similar system, we only asked for a minimum of thirty lamps, which was soon obtained. Different hours were required in this case; and six nights per week instead of five. This made an average of seven hours extra consumption per week, representing nearly 4000 cubic feet more per lamp per annum. But as other costs amount to about three-quarters of the whole, the gas itself is comparatively unimportant; so that an additional charge of only 2s. per quarter was made. Even on early closing

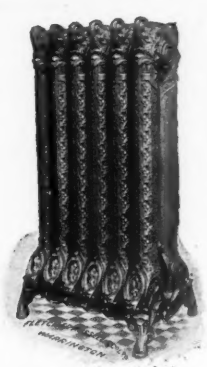
GAS FIRES AND RADIATORS

FOR HIRING OUT.

"Palermo."



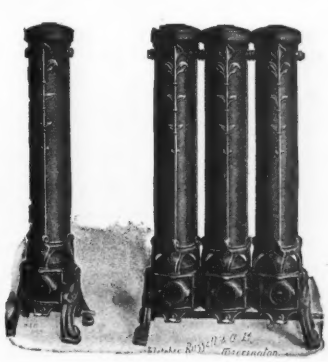
"Floral."



"Ivor."

"Tokio."

"Borneo."



"Ariel."

FLETCHER, RUSSELL, & Co., LTD.,

• • •

WARRINGTON, MANCHESTER, LONDON, AND BRUSSELS.

NOTE: Our Geyser Competition WILL CLOSE on Nov. 30, and cannot be extended.

"IRONCLAD"

Upright and Inverted

INCANDESCENT GAS MANTLES.

Note the Patent Metal Top.

UPRIGHT—

PATENT METAL TOP.

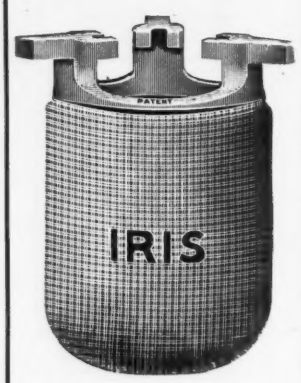
Hang Steadier than any other Gas Mantles.

INVERTED—

"IRIS BRAND."

Give a truly brilliant light.
Universal Ring to fit any Burner.

"IRIS" Brand Inverted.



THE BEST OBTAINABLE.

BRILLIANT LIGHT. STRONG AND DURABLE.

BRITISH MADE.

The Best Obtainable for Street Maintenance and other Lighting Purposes.

FULL PARTICULARS FROM SOLE MANUFACTURERS:

CURTIS'S & HARVEY, LIMITED,

HEAD OFFICE:

3, Gracechurch Street, LONDON, E.C.

A View of the Same Thoroughfare from the Opposite Direction to that on page 482.

nights, the continuation of the lights forms a good advertisement where the trade or business of the shop is conspicuously painted on the shutter.

This installation was started in July, 1909, and was rapidly followed in November by the northern part of Wood Green, where only twenty guaranteed orders were asked; and by Middle Wood Green, and a branch road (Myddleton Road), in December. In the two latter cases, we asked no guarantee as to numbers, as our past experience showed that orders were easy to obtain as soon as the supply was available. A good illustration of this is in what is known as "Costers' Market," where twenty lamps are subscribed for by the stall-holders. It is worth mentioning here that the freer from stringent conditions the offers are made, the more readily they are accepted. The Tottenham Company only ask for a year certain, and afterwards a month's notice.

Central Compressing Station.

Having now five separate centres in about 2½ miles of practically the same road, with only small spaces between, it was decided to join all up and work from a central station. This was done in August this year; and the compressing is now done entirely at the Company's Wood Green depôt, which is centrally placed. For compressors, two 25,000 feet per hour Donkin's exhausters, which the Company had among its spare plant, were used, and driven by a "M." type 8 H.P. gas-engines. The gas is drawn through a 10,000 cubic feet per hour station meter, which also came from the stock of spare plant. In order to avoid any pulsation on the high-pressure main, the gas is discharged into the upper part of a 36-inch vertical pipe, 6 feet high, with closed top and bottom; the bottom being connected by a 4-inch pipe to another 36-inch vertical pipe, 12 feet high, with closed bottom and open top. The two pipes are filled 5 ft. 6 in. deep with water. As the pressure accumulates after starting the plant, the water flows through the 4-inch connection until it balances the pressure, and thus not only forms a cushioning surface, but also a slight reservoir of compressed gas.

With central working, provision had to be made for varying times at different centres; but this was in this case easy, as the short-time districts—Harringay and Myddleton Road—are at the two extremes. Valves were introduced for shutting off these districts when required; and in order to maintain the bye-passes when the valve is shut, a 1-inch connection with a back-pressure valve is made to the low-pressure main on the outlet side of the valve. This admits low-pressure gas for the bye-passes when the main valve is shut.

This combination has been applied in another form. Some public lamps are on high pressure; but as the compressors stop at ten o'clock on the first four days of the week, at eleven o'clock on Fridays, and at twelve o'clock on Saturdays, a light is still required in the public lamps for the remainder of the night. The columns are therefore fitted with a high-pressure lamp and a low-pressure lamp; the latter being fitted with a Rostin self-lighter. The high-pressure plant is invariably started before the time for lighting the public lamps, and therefore before the Rostin lighter tries to operate. When it does try, it finds itself held down by a high-pressure diaphragm, and it is only able to act when high pressure goes off at shutting-down time. It then lights the low-pressure lamp, and in the morning extinguishes it with the others, as there is then no high pressure to interfere with its functions.

Financial Points.

As nearly as possible our costs at the central station, as ascertained so far, promise to come out—taken on the number of lamps at present (558)—at about £1750, and our revenue at £2250, leaving a margin of £500 for depreciation. As regards depreciation, the lamps are so well constructed that they may be confidently expected to last ten years. We are so satisfied with the result, and the system is so popular, that we have started new centres without asking for any guaranteed number as follows: West Green Road, Bruce Grove area, Criterion Buildings (near our Central Office), Lordship Lane, and The Broadway, Winchmore Hill. Other busy centres will soon be dealt with, until in practically all main roads we shall shortly have high-pressure supplies throughout their entire length.

Light for light, with gas taken at a general average of 3s. per 1000 cubic feet, and electricity at the low price of 3d. per unit, the cost for 10,000 candles maintained one hour is:

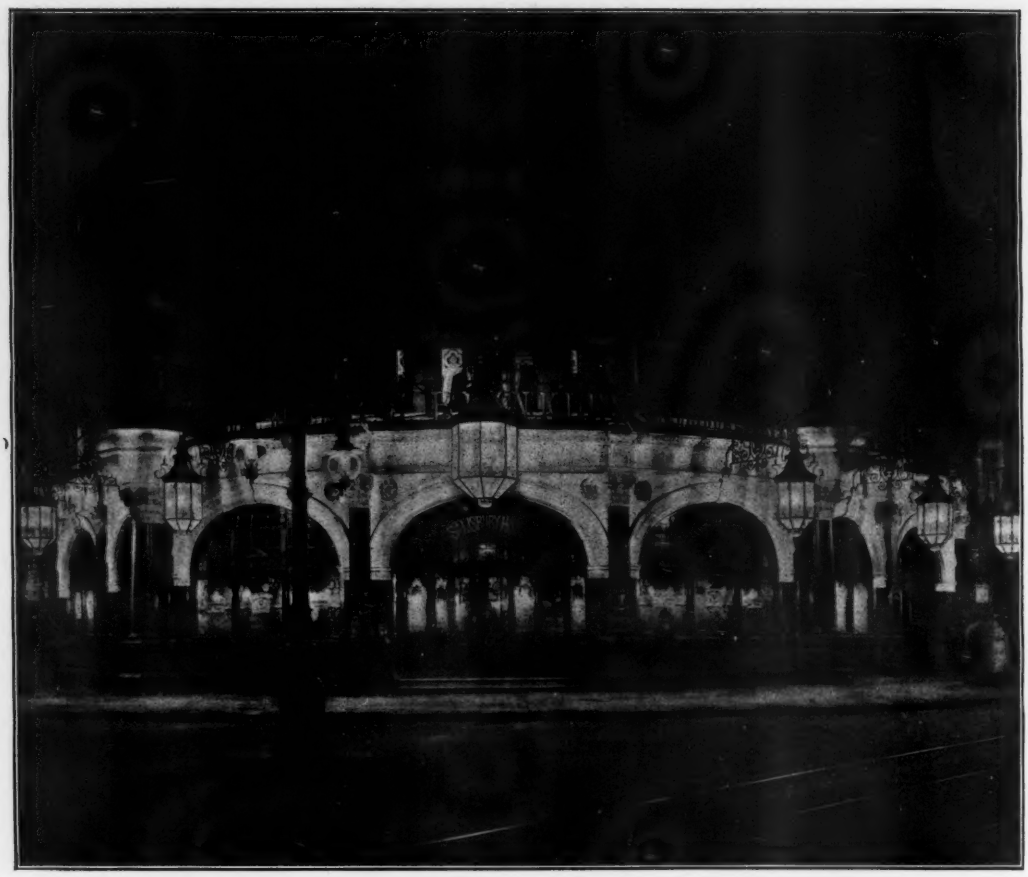
Keith inverted gas-lamps	0s. 6d.
Low voltage osram electric	2 6
Electric flame arcs	0 11

This is for gas and current only. Maintenance is all in favour of the high-pressure gas system; while the steadiness and brilliance of the light, and its superior diffusive power, appeal to all who have used it.

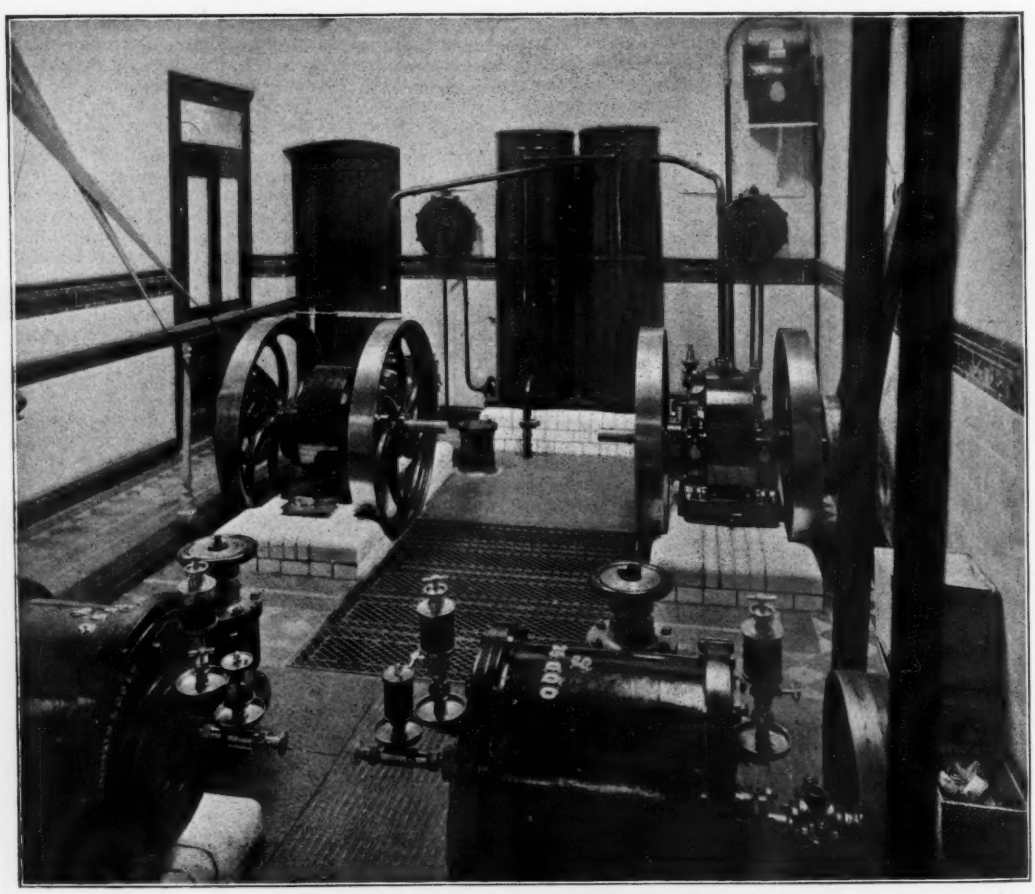
Other Installations, and the Question of Ignition.

On the Tottenham district there are several fine instances of high-pressure factory installations, skating rinks, market halls, &c.; but these it is not proposed to describe. The installation at the Alexandra Palace, however, is of a public nature, and is worthy of particular notice.* The most novel feature is the very neat switch-board, by which various halls and sections of the buildings and grounds can be operated separately by merely turning an extremely small high-pressure gas-cock for each section. The method of operating is as follows: Beneath the floor of the compressor station there is a diaphragm governor for each

* The Alexandra Palace installation was described and illustrated in the "Journal" for Nov. 16 last year, pp. 462-4.—Ed. J.G.L.



A Brilliant Example of Hotel Lighting in the Tottenham Company's District (Sugg Burners).



The Central Gas-Compressing Station at Wood Green.

section, whose function is to cut down the high pressure on sections which are for the time being shut out; so that the valve of the distance lighter (already described in connection with each lamp) is closed, and only the bye-pass open to the reduced pressure. Behind the switch-board there is a ⅜-inch supply of high pressure when the compressors are running; and from this supply a ⅛-inch cock and tube connect with the space above the diaphragm of each section governor.

When the ⅛-inch cock is opened, high pressure (but comparatively no volume) passes to the top of the diaphragm, equalizing the high pressure below it, and thus throwing it out of action as a governor. It consequently admits gas at full high pressure to that section. This operates the automatic lighter on each lamp of the section, and cuts down the bye-pass; and all the lamps are thus lighted. In order to extinguish them, all that is needed is to shut off the switch cock, which, in shutting off, vents the small quantity of high-pressure gas that is contained above the diaphragm of the section governor, and allows it to become operative again in reducing pressure on the section; thus shutting the automatic lighters and reopening the bye-passes.

On the subject of bye-passes, these are undoubtedly expensive in such a building as the Alexandra Palace, where some sections are only lighted for a few hours per week, with the result that the bye-passes use more gas in the aggregate than the burners themselves.

This difficulty can be overcome by electric ignition. And here comes in a peculiar position for our energetic rival electricity. It is but another proof that expensive things can often be beneficially used in a small way; and in this case it is indeed in a very small way, as it only needs some small dry-cell batteries.

There are two systems which might be used; one is the Keith-Blackman system, by which from a set of central batteries wires can be run to the lamps in the various sections, and instead of the automatic lighter already described, a momentary current opens an electric control valve on each lamp, and at the same time ignites the gas. This necessitates a considerable amount of wiring; but as it has not been adopted, it need not be described in detail.

The other system is an invention of Dr. Rostin; and as the Trustees of the Alexandra Palace have ordered 121 of these lighters, a description may be found of interest. By taking a supply of gas from above the lamp to an ingenious apparatus connected with the self-lighter already described, Dr. Rostin causes a diaphragm to rise synchronologically with the opening of the self-lighter, admitting gas to the burner. The rise of this diaphragm opens a cock on the ordinary bye-pass tube, and at the same time gives an electric contact to a platinum igniter placed at the bye-pass orifice from a small dry-cell battery placed in any convenient position. The action of the diaphragm is retarded, not only as regards the admission of gas under it, but also as regards the escape of air above it, by adjusting screws. The high-pressure gas is thus allowed to issue from the bye-pass for about 15 to 20 seconds, and is ignited by the platinum wire that is heated by the electric current passing while the contact remains. The bye-pass flame shoots right across the mantle, and ensures safe lighting. At the finish of the retarded action of the diaphragm, the bye-pass cock (which is the ratchet type usually favoured by Dr. Rostin) closes by travelling on beyond the port, and the contact also is broken. The dry-cell battery, which costs only 10d., lasts six months, and the igniter, which lasts a year, can be renewed for 6d. By this apparatus, the waste of the bye-pass is quite obviated.

Enterprise the Developing Factor.

This paper has become somewhat lengthy; but as it deals with one of the important changes through which our industry is passing, the author hopes it may prove useful. The lesson to be learnt is that, notwithstanding the great progress already made, gas still has an immense reserve of potentiality untouched by scientific practice. In the past, there has been in our industry too much easy reliance on our developed strength, and too much hesitancy in doing our best with possible improvements, which only require enterprise to attain marked success.

MIDLAND JUNIOR GAS ASSOCIATION.

The November Meeting of the Midland Junior Gas Engineering Association was held at Birmingham on Saturday, under the presidency of Mr. R. S. Ramsden, of Burton-on-Trent.

The Hon. Secretary (Mr. G. C. Pearson, Nechells) read letters from Mr. Vincent Hughes, of Smethwick, and Mr. B. W. Smith, of Walsall; and also one from Mr. C. G. Langford, of Coventry, resigning his position on the Council, owing to his having obtained an appointment in South America.

Mr. W. H. Johns, of Saltley, read a comprehensive paper entitled "Ammonia Recovery, with Special Reference to Apparatus employed therein," which was illustrated by a number of models and tracings. The paper appears on p. 489 of this issue; but the report of the long and interesting discussion to which it gave rise has been crowded out, and will be given next week.

At the conclusion of the business meeting, the first of a series of "Coffee Meetings," was held at the Metropole Café; and this proved a highly successful innovation for the Association.

LONDON AND SOUTHERN JUNIOR ASSOCIATION.

Visit to the Brentford Gas-Works.

On Saturday, between forty and fifty members of the London and Southern District Junior Gas Association visited the Brentford Gas-Works. The members were met at the entrance to the works by Mr. A. A. Johnston, the Engineer and Manager of the Company, and Mr. R. Goodman, the Assistant-Engineer, who, with Messrs. T. Antrobus, C. Bedford, D. Sugg, N. Willsmer, W. Lewis, P. Parry, T. Parry, L. J. Croxford, and E. Waterfield (members of the staff), divided the party into groups, and conducted them over the works and through the various shops—the latter being kept running and fully staffed for the occasion.

BRENTFORD GAS-WORKS.

The Brentford Gas Company were incorporated by Act of Parliament in 1821; and further powers were granted in 1858, 1868, 1876, and 1881. The Company have two works—viz., at Brentford and Southall; the distance between them being 5½ miles. The district supplied by the Company comprises about 50 square miles, and includes the parishes of Brentford, Chiswick, Hammersmith, Acton, Ealing, Hanwell, Greenford, Southall-Norwood, Heston, Isleworth, part of Twickenham, Hayes, Harlington, Cranford, East Bedfont, Kew, Mortlake, Barnes, and part of Putney. During the past ten years the output of gas has increased from 1807 million cubic feet to 2898 millions per annum; being equal to an increase of 60 per cent. The Brentford works are situated on the River Thames about one-third of a mile above Kew Bridge. There is no railway connection with the works; all coal, oil, &c., being brought by water. The site being exceedingly restricted, every available corner is used to its utmost capacity. The total area of the works is 5·5 acres; the area available for manufacturing purposes being but 1·9 acres.

The coal-stores have a total capacity of about 7200 tons; and provision is made for storing 171,000 gallons of oil.

The carbonizing plant, capable of producing 2,800,000 cubic feet of gas per diem, consists of three retort-houses—two containing one bench of eight settings each, and one house containing sixteen settings in one bench; making a total of 32 sets, or 192 retorts in all. All the retorts are inclines, 20 feet long of Ω section, 24½ in. by 14 in., set at an angle of 31°, six retorts in a setting, heated by regenerator furnaces.

The coal is brought alongside the works in barges, whence it is raised by grabs to the coal-breakers, from which it passes to the boots of elevators, which raise it to conveyors running over the storage hoppers which are fixed along the entire length of each retort-house. The coal then passes to measuring chambers, from which it is conducted into the retorts by movable shoots—one shoot for each tier of retorts. Over the coal-breaker of No. 2 house is fixed a totalizing hopper-weigher machine.

On leaving the retorts, the gas passes by way of the hydraulic mains to long cooling mains, along the walls of the retort-houses, and thence to two sets of Clapham's "Eclipse" reversible water-tube condensers of 1½ million cubic feet per diem capacity each.

The exhauster-house contains three exhausters—two of 125,000 cubic feet per hour capacity, of Messrs. Gwynnes' make, and one by the Bryan Donkin Company, driven by countershaft and belting from two horizontal jet-condensing steam-engines of 15 H.P. each. The gas passes from the exhausters through a series of four tower scrubbers.

The purifiers for coal gas consist of seven boxes—four 20 ft. by 40 ft. by 6 ft. deep, and three 30 ft. by 30 ft. by 7 feet deep—and two catches, each 40 ft. by 19 ft. by 6 ft. deep. Oxide of iron only is used in them.

From the purifiers, the gas passes to the station-meter, to be described later.

The carburetted water-gas plant, supplied by Messrs. Humphreys and Glasgow, consists of two sections of a million cubic feet per diem each and one section of 700,000 cubic feet per diem capacity. No. 1 set, which has lately been remodelled, is fitted with steam meters and electric pyrometer; and all the sets are provided with Humphreys and Glasgow's dust interceptors on the stacks of the superheaters.

The engine-room contains three Sturtevant No. 8 blowers; two being driven by means of countershafts and belting from Marshall high-speed horizontal non-condensing steam-engines, and one coupled direct to a De Laval non-condensing steam-turbine of 55 H.P. There are also two exhausters of 40,000 cubic feet per hour capacity each, coupled direct to horizontal steam-engines of Gwynnes' make. The various pumps for oil, circulating water, &c., are by the Worthington Pump Company. Before going to the purifiers, the gas passes through a "Cyclone" tar-extractor, and thence to the relief holder, which is of 60,000 cubic feet capacity.

The purifiers consist of four boxes, 29 ft. by 16 ft. by 6 ft. deep; oxide of iron being used in them. The gas is then measured by a station meter of 80,000 cubic feet per hour capacity, and afterwards mixes with the coal gas on its way to the holders.

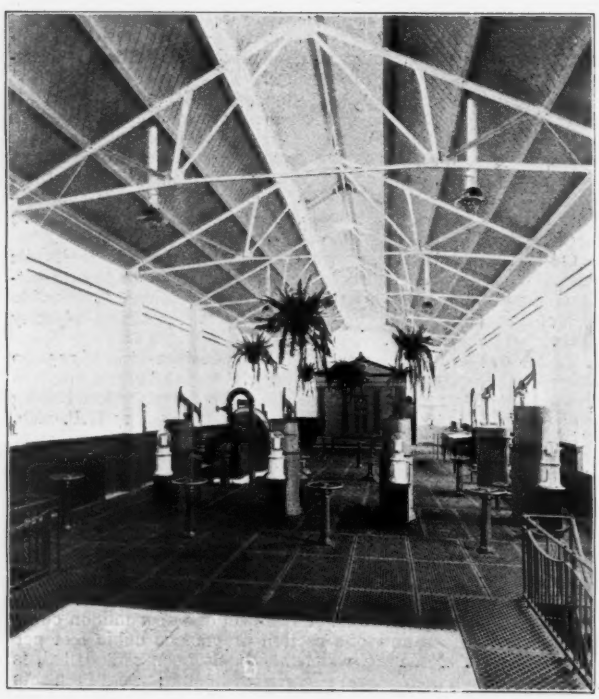
Steam is supplied to the various engines and pumps, &c., on the works and to the carburetted water-gas plant by a battery of four Lancashire boilers, 6 ft. 6 in. by 26 ft., fitted with forced

View of the Brentford Gas-Works from the River Thames.

draught furnaces and regularly working at a pressure of 110 lbs. per square inch.

The remaining portion of the works is situated on the north side of the High Street.

The valve and governor house, a spacious building 110 ft. in length and 32 ft. wide, has but recently been completed. It is constructed of hollow concrete blocks made of coke breeze and portland cement. It consists of two floors, on the lower one being the various connections, ranging from 18 inches to 40 inches in diameter. The upper floor is of cast-iron perforated plates on cast-iron columns and steel framework. The building contains the coal-gas station meter, district governors, turbo-booster and holder valves. The station meter was made by Messrs. W. & B. Cowan, of 100,000 cubic feet per hour capacity. The district governors, of which there are four (three being 18-inch and one 24-inch) are of Braddock's water-loaded type. There is



Upper Floor of the Valve and Governor House.

also a 24-inch safety governor of the same make. The booster used consists of a Sturtevant gas-pressure raiser coupled to a De Laval steam-turbine of 55 H.P., and is for forcing the gas from one holder into another, or straight on to the district if required. The connections for the three holders are brought into the basement of the house; the inlet and outlet valves of holders being inside the building.

There is a 30-inch main connecting the Southall works with Brentford; and this main is brought into the valve-house and connected to the inlet and outlet of holders, district, and to the booster.

There are three gasholders, of 876,000, 522,000, and 304,000 cubic feet capacity respectively.

Opposite to the valve-house are the gas-stove repairing shops, which are completely fitted up for the cleaning and repairing of cookers, fires, &c. There is a furnace to hold 22 cookers for burning-off, after which the stoves are cleaned by a sand-blast apparatus. The main repairing shop contains drilling machines, emery grinders, buffing wheels, shearing machines, &c., driven by a gas-engine; also tools and machines for making the various tins, flue-pipes, &c., required. An average of about 220 stoves are turned out weekly.

The Company do not at present repair meters; but all meters are tested at the works, for which purpose four test holders are installed, which deal with about 240 meters weekly.

The various workshops, some of which are at present being reconstructed, comprise smithy, with four hearths and pneumatic power hammer, carpenters' shop, fitting and machine shops, coppersmiths' shop, and lamp-repairing shop.

The general offices and stores are on the Brentford works.

At the conclusion of the inspection, the company assembled in the governor-house, where tea was provided. After tea,

The PRESIDENT (Mr. L. F. Tooth) expressed the appreciation the Association felt for the privilege of the visit that day, and called upon Mr. T. F. Canning (Senior Vice-President) to move a vote of thanks.

Mr. CANNING said that he had much pleasure in proposing a vote of thanks to the Board of Directors of the Brentford Gas Company, and to Mr. Johnston, Mr. Goodman, and the other members of the staff, for their kindness in having the members at the works that afternoon and for their generous hospitality. They had been greatly interested in all they had seen, and were particularly struck with the arrangements at the Brentford works, where there was an output of 5½ million cubic feet per diem, on a manufacturing area of under 2 acres; it was an experience of practical work and improvements in unfortunate surroundings. Mr. Johnston had proved himself equal to the occasion; and he hoped in years to come to renew the acquaintance of Brentford by making another visit. Special thanks were due to the Engineer for keeping the stove cleaning and repairing shops in operation that afternoon. They had evidently seen the last word in stove work.

Mr. D. J. WINSLOW, in seconding the vote, said the afternoon had been a good educational visit. They had seen how disadvantages could be turned to advantages, and obtained hints which would prove most useful.

The vote having been carried,

Mr. A. A. JOHNSTON thanked the members for their vote. He said that the visit had been a great pleasure to him. His first experience of Junior Associations was when he visited the Junior Gas Engineering Society, held under the Welsh Chapel in the City Road, some twelve or fourteen years ago. Of this Society he was then a member; and he believed it was the pioneer of the Junior Associations in the kingdom. At that time there was none other existing. Another reason why the visit had given him pleasure was because visits of this sort were not only interesting, but they must tend to the good of the industry. Brentford was not a show works, owing to the difficulties that had been alluded to by a previous speaker.

The late Mr. John Birch Paddon, whose death was recorded in the "JOURNAL" for the 18th ult., left estate of the value of £43,597, with net personalty sworn at £35,564. Probate of the will, dated Nov. 27, 1903, has been granted to his son, Mr. Arthur Matthews Paddon, of the Middle Temple, Barrister-at-Law, who is one of the Directors of the Brentford Gas Company. Among the bequests are £50 each to Mr. E. L. Burton and Mr. Joseph Cash, the Secretary and General Manager respectively of the Brighton and Hove Gas Company, with which the testator was connected for so many years; and £25 to Mr. A. W. Cooper, of the Malta and Mediterranean Gas Company. The Trustees under the will are directed to have constructed on some safe part of his estate a furnace wherein they shall cause to be consumed all his letters, letter-books, specifications, engineering drawings, &c., except such as they shall consider it desirable to preserve.

MEETING OF THE AMERICAN GAS INSTITUTE.

Extracts from the Presidential Address of Mr. W. H. Bradley.

In the brief notice of the recent annual meeting of the American Gas Institute which appeared in the "JOURNAL" last week, it was mentioned that the President—Mr. W. H. Bradley, the Chief Engineer of the Consolidated Gas Company of New York—devoted his address mainly to the question of maturing and spreading the interests of the Institute. The following is a general outline of the address.

INTRODUCTORY.

After extending to his colleagues a hearty welcome to the Empire City of the Empire State, the President expressed his pleasure at having in the full attendance of members many who had journeyed far from distant cities to take part and assist in the work of the organization. The usual presidential address which was expected on these occasions would, he said, be necessarily brief, as the Technical Committee had prepared a programme of unusual length and variety that would require all the time at their disposal to complete. He would, therefore, only touch on such matters as appeared to be important as concerning the Institute and its work, and one or two subjects of general interest to the members, and not attempt to discuss matters of published record so readily available to all in the columns of the Technical Press. It had been suggested that he should discuss the present policy of the Institute, and outline a future one. It was not, however, within the province of the individual, except through the medium of the Directors, to indicate what should be its future policy. But it might not be amiss to consider for a few moments the general situation, after four years of life of the Institute, and see if any information could be gained, or any conclusions drawn that had a bearing on present conditions as they might seem to exist; and, if improvement was desirable or possible in the tone or work of the Institute, how this could be made.

THE INSTITUTE AND ITS MEMBERS' DUTIES.

Referring first to the consolidation of the American, Western, and Ohio Associations into the Institute, the President said it was evident that the one thought in the minds of those who brought forward the proposal was that in union there was strength, and that one organization under favourable conditions, and loyally supported by all its members, could, and would, do better and more efficient work than could be expected from many small organizations, each working independently of the other. That this was correct in theory was beyond dispute; but it did not seem to have fully worked out in practice. Many new State and District Associations had since been formed, and others were contemplated; so that there were now many more than at the time of the formation of the Institute. In addition to these, there were the Illuminating Engineering Society and the National Commercial Gas Association, both comparatively new organizations. It was an undeniable fact that the work of these two Societies ran in parallel lines to that of the Institute. This was recognized last year in Detroit; and at the meeting a resolution was passed having for its purpose some form of amalgamation with the latter organization. This became impossible at the time, because of the decision of the Gas Association that it would not be to its advantage to make any arrangement of the kind at present. It was, however, possible, and even probable, that the question might be brought up again during the coming year.

With regard to the success of the Institute as now constituted, the President pointed out that it depended not alone on the efficiency and work of its officers and Committees, but also largely on the cordial support and assistance given them by the individual membership. "If," said Mr. Bradley, "we believe that we fill the measure of our responsibility to ourselves, to the companies we represent, or to the Institute, by simply paying our annual dues, attending the annual meetings, and returning to our respective homes, giving no further thought to the Institute and its work until the occurrence of the next annual meeting, then there is grave danger that the control of the Institute and its affairs will pass into the hands of the few, or working members, instead of remaining in the hands of the many, as it should for the benefit of all concerned."

THE PREPARATION OF PAPERS.

Passing on to consider the technical work of the meeting, the President remarked that there was only one paper that could be called a voluntary contribution; and he pointed out that the great majority of them were from members connected with the larger companies. This fact had, he said, been commented upon before; and he thought it should be corrected. On this subject, he made the following remarks: We have young men, managers and engineers of the smaller installations, who have both the ability and opportunity to prepare papers that would prove valuable and instructive; and it is eminently desirable, for the benefit of the Institute and the entire membership, that they should come to the front, and take an active part in this work and also in the management of the Institute. They should not hesitate because of a feeling of youth and inexperience; quite as much, and perhaps more, consideration will be shown them by the Institute because of this fact. The older and more experienced members are fully aware that they are not yet the custodians of all the knowledge to be obtained in the gas industry, and are all willing to gain more knowledge, even from the young members. It is neither necessary nor desirable that all papers should be severely technical. Popular papers, if I may so term them, relating to methods of operation or construction; records and results of experiments carried on with a definite purpose; notes on new, or changes made in old, distribution systems; on the uses of gas; and papers on business methods—these are but a few of the topics that would be always welcomed with the technical papers. Even records of failures are valuable. I assume there are but few of us who have not, at times, made failures; and while it is all-important that we should know what to do, it is equally important to know just what not to do. Again, the managers or engineers of the smaller installations are able to observe and attend to matters of detail—so desirable in preparing papers—to an extent that is not possible with the managers or engineers of the larger installations, who must, of necessity, delegate much of the detail work to others.

THE EDUCATIONAL WORK OF THE INSTITUTE.

Dealing next with the educational branch of the Institute's work, the President said few, except those who had been brought into contact with it, had any conception of the amount of time and labour given, freely and without stint, by the Trustees in carrying on this work. He thought the members should endeavour to assist and encourage them in every way possible—perhaps by suggesting to the financial officers of the companies not already subscribing that a subscription to the fund would be acceptable and useful, by looking over gas makers and others employed on the works, selecting those likely to become interested in the subject of a better education, suggesting the matter to them, and, if occasion presented itself, assisting them to solve the problems given out in the various classes, and thus reap their reward in the consciousness that they had done something to forward the Institute's work, and at the same time increase the self-respect, the efficiency, and the value to their company and themselves of some of their co-workers. He added that he had been prompted to make these observations solely with the sincere wish and hope that the result might be the awakening of more of the members to a fuller appreciation of their duties and their privileges in the Institute, and in this way initiate an era of progress and of interest that would result in placing it in the position to which it rightfully belonged—viz., in the front rank among the technical societies of the world.

THE PROPOSED ADOPTION OF A CALORIFIC STANDARD.

Coming to subjects of more general interest to the gas industry, the President said the suggested change in the standard of value as applied to the use of gas—the adoption of a calorific standard in place of the photometric one—was perhaps the most important. The proposed standard had, he pointed out, been already adopted in some States of America, and was being seriously considered in New York, as well as elsewhere. It had also been adopted to some extent in certain places in Europe. The advocates of the change argued that, as gas is so largely used for obtaining heat and power and for lighting purposes with the incandescent mantle burner, the thermal value is of more importance to the consumer than is the illuminating value. If this was conceded, it logically followed that in every case where the thermal standard is adopted the illuminating standard should be eliminated. So far as information was obtainable on this subject, no definite or constant relation had been established as between candle power and thermal value. Considerable variation might occur in either one without corresponding or even relative variation in the other. Any attempt, therefore, to enforce compliance with two standards of manufacture, in the present state of affairs, would simply result in gas suppliers being penalized for non-compliance with one, while entirely in compliance with the other. This in itself was a sufficient argument for a single standard.

THE INSTITUTE'S INVESTIGATIONS ON CALORIMETRY.

Reference to the proposed adoption of a new standard for gas naturally led the President to the subject of the work of the Institute in connection with calorimetry. He reminded the members that for some time past the Institute had had Committees on this subject who had done much valuable work, and had from time to time made reports. Up to the present, in accordance with their instructions, the work had been confined chiefly to the examination of the several types of calorimeters on the market, the comparative results to be obtained by their use, and to formulating rules for the proper method of installing calorimeters and conducting tests. The President said he believed the time had arrived for the members to consider the propriety of enlarging the scope of these Committees by giving them instructions to take further steps, until, by research and experiment, they were able to make a report to the Institute as to what should be the logical standard of thermal value for the gases manufactured in different localities, considered from the standpoint of a gas useful for the purposes required, as well as its economy in manufacture. A report of this character, well considered and matured, and having the endorsement of the Institute, would, he said, have much weight with those who are investigating the subject with a view to making a change of standard, as coming from a body well qualified to give expert advice on the matter. The present Committees were in possession of much useful information upon the subject; and he thought they should be continued.

GOVERNMENT BY COMMISSION.

The next subject taken up was that of "Government by Commission." This idea was conceived some years ago, when the

National Government placed on the Statute-books laws having for their object the regulation and supervision of corporations, especially those classed as "public utility corporations," in which class, among others, gas companies are included. The lead of the Federal Government was followed by the legislative bodies of the several States, with the result that many laws were enacted, more or less drastic in character, according to the temper of the legislative bodies at the time and the demands of so-called "public opinion." Public Service Commissions were evolved from among these laws; and they are now exercising their functions in several States. In some localities, and under some laws, these functions are extended to a point dangerously near to control of operation. The President made the following remarks on this subject: A Public Service Commission *per se* is not necessarily harmful or objectionable to corporations. A commission whose members are broad-minded, experienced in business methods, and who will take the time to acquaint themselves with the business of the corporations before attempting to supervise or regulate them, who will recognize the fact that the interests of the corporations and the public are identical, that disputes or misunderstandings should be amicably settled, and that both have their rights—among them being the right of the corporation to exist and do business and earn a fair return on the capital invested—will be beneficial to both corporations and the public. If, on the other hand, a commission be composed of those who are unaccustomed to handling large enterprises, men of narrow minds, or politicians appointed by reason of service rendered to party or person, whose whole conception of the duty of a commission is to make a reason for its existence and continuance, and who, therefore, promote strife as a means of gaining notoriety and consequent personal or political advantage, or both, then the result is distinctly bad, not only for the corporation, but also for the customer and the public.

MANUFACTURE OF PUBLIC OPINION.

With regard to "demand by public opinion," the President characterized it as the "shibboleth" always used by those interested in procuring legislation favourable to their own interests. His views on this subject he expressed as follows: If we look into the matter, we find "public opinion," so called, is strictly and wholly a manufactured article—manufactured by politicians and others interested in furthering their own or their party schemes, which are ofttimes actually detrimental to public policy and the general welfare of the community. The general public, not having the requisite knowledge to enable them to form definite opinions, are always ready to accept measures that seem on their face advantageous to their interests. This being the case, why should we not endeavour to mould public opinion, and by this means counteract, as far as possible, the effects of false, misleading, and garbled statements that are so freely used to our disadvantage. Such a method of procedure is entirely feasible, and can be accomplished by inaugurating a scheme of publicity of the details of our business to such an extent as will satisfy all reasonable people that we are dealing, in every way, fairly and honestly with them.

Let us give out periodical statements or reports in any way or form best suited to reach the public, according to existing conditions in any given locality—in other words, take the public into our confidence, and by this means create public opinion that is if favourable to our interests, in place of an antagonistic feeling, if it exists. An immediate change will not take place; but this course persisted in for a time will, without question, bring favourable results. If a Public Service Commission law is enacted and becomes operative in any State, then publicity of every detail of our business will be obligatory. Public opinion will be more in our favour if we do this voluntarily than if it is done under compulsion. It is fair to assume that a system of publicity, inaugurated and carried out in good faith with the public, will be of advantage to any company, by preventing, to a great extent, litigation, with its attendant expense and trouble, and make investigations and the enactment of laws prejudicial to the best interests of our industry much less popular. Another step in the same direction is to insist that all employees of the company who in any capacity come in personal contact with the public shall be courteous, and avoid giving offence or cause for complaint. Unpleasant relations that are entirely unnecessary between the company and its patrons are readily caused by a disagreeable manner and incivility on the part of clerks and other employees. This is not a matter to be overlooked. Discourtesy on the part of a company's employees will easily nullify any efforts of its officers to bring about friendly relations with the public.

POSITION AND RESPONSIBILITIES OF THE GAS INDUSTRY.

The President next referred to the excellent position of the gas industry in America, as shown by the substantial increase which has taken place in the sale of gas over the entire country; and he said he thought there was every reason for believing that similar conditions would obtain in the future. He pointed out that contracts were being made for the erection of new plants in many localities, and for alterations and extensions of existing plants. This was evidence of the healthy condition of the business, notwithstanding the attacks that had been made upon it in the past, and the further fact that the business of their neighbours who are engaged in generating and distributing electric current was also rapidly increasing. The President's further remarks on this subject were as follows: In the early days of gas manufacture, gas was considered to be a luxury; later, when electricity came into the field, that also was a luxury. That time has passed. Both are now necessities, indispensable to the comfort and welfare of our people. Each has its place, its work, and its use. Each will take and hold its place; and the use of each will be constantly on the increase. They will both become more necessary and more indispensable to the entire community as the years roll round. There can be no ground for fearing that either one will or can interfere with the other in its place, work, or use, to any appreciable extent or for any appreciable length of time. The public require and demand more light, and more convenient methods of obtaining light, than in former days. Gas is being more freely used; and its field of use extended in directions and to an extent never dreamed of in days that are easily within the memory of many of us. But we must not be content with this, and so cease our efforts to acquire new, and increase our present, business over and beyond the natural increase. We must get in touch with our customers. If any are still using the old open-flame burner, now practically discarded and obsolete, see that they are shown the advantage to them in the use of the incandescent mantle burner; see that they are supplied with cooking and heating appliances of new and approved pattern and design, at a nominal rental, or at a nominal cost price if purchased; see that all appliances are properly installed and adjusted, and that full instruction is given as to their care and use; advertise freely in the local papers, and a large volume of business now lying dormant will be brought into active life. No company is too large or too small to inaugurate a business campaign in this direction.

Many gas companies are already in the field, and in every case with most satisfactory results. Most consumers are pleased with the attention shown them; and every pleased consumer helps, aids, and assists by a certain amount of gratuitous advertising among friends and neighbours. Our electric friends have their own methods of gaining business. Their methods are not necessarily competitive, except in the one field of lighting. There we must endeavour, as far as possible, to hold our own through the greater volume of light obtained per unit by the use of the incandescent mantle, if it comes to competition. Another advantage to be gained from a general use of gas for purposes other than lighting is that the consumption is spread more uniformly over the 24 hours of the day. In some cases, where there is a considerable increase in the use of gas for cooking and heating, the daylight output is gaining rapidly, and approximates fairly well with the output during the hours when darkness prevails. This also has a beneficial effect on manufacturing and storage conditions. The National Commercial Gas Association are our active allies along these lines. It is their business to introduce appliances; ours to provide use for them.

POSITION OF THE INSTITUTE.

The President closed his address with some remarks on the position of the Institute, and a reference to the members who had passed away during the year. He said the report of the Treasurer showed an improved financial position—there being a substantial surplus, with no outstanding liabilities of any consequence. The report of the Secretary showed a net gain in membership of 16; making a total to date of 1348 members. During the year, 87 new members had been elected, and 71 were lost through resignation, death, and by being dropped from the roll. The work of the several standing Committees had been well and faithfully performed, so far as it was within their power to perform it—notably the Committee on Standardizing Cast-Iron Pipe, which had been held over for several years. The Technical Committee had done an immense amount of work. Eleven members had been removed by death. One of them was Mr. Thomas J. Hayward, the President of the well-known Bartlett-Hayward Company, of Baltimore, whose decease shortly after the meeting of the Institute last year was referred to by the President as "a distinct loss to the whole profession." Being always "helpful and resourceful in business, never refusing to aid with advice and substantial assistance when appealed to, he would," said the President, "long be remembered by many who were so fortunate as to be numbered among his intimate acquaintances."

Photometric Work at the Reichsanstalt in 1909.

The report on the work of the Physical Technical Imperial Institute (Reichsanstalt) at Charlottenburg for 1909 states that many tests have been made as to the durability of metallic filament electric lamps. These lamps at first consumed 1·1 watts per hefner mean illuminating power measured at right angles to the axis of the lamp, which is equivalent to 1·2 watts per candle. After prolonged use, the light of these lamps had fallen off by 20 per cent., though in other cases the lamps were burnt out before the falling off in light reached this proportion. Tests of inverted gas-lamps showed that in the best examples the consumption of gas was 1·2 litres per hefner mean spherical illuminating power (21·1 candles per cubic foot of gas consumed). Incandescent burners for acetylene, in the most favourable cases, showed a consumption of 0·2 litre of acetylene per hefner mean horizontal illuminating power (127 candles per cubic foot of acetylene consumed). The report also mentions that the Institute has been occupied in the testing of all kinds of mantles and lamps for assessing them for the new tax on illuminating agents in Germany. It has also been conducting negotiations with similar bodies in other countries with a view to the establishment of an "International Unit of Light."

AMMONIA RECOVERY, WITH SPECIAL REFERENCE TO THE APPARATUS EMPLOYED THEREIN.

By W. H. Johns, Superintendent of the Saltley Gas-Works, Birmingham.

[A Paper read before the Midland Junior Gas Engineering Association, Saturday, Nov. 12.]

The absence from our "Transactions" of any paper dealing with the subject of ammonia recovery, as well as the scarcity of such papers read before other Associations, has led me to comply with the President's request to submit to your notice a paper which I trust may be of some service to members. At the same time, I realize the impossibility of dealing completely with so important a subject within the limits of an ordinary paper.

Ammonia may be obtained from sewage, bones, horn, leather, coal, and other substances; it is produced in coke-ovens, producer-gas and blast-furnace plants. But it is the recovery of the ammonia that is liberated from the coal in the manufacture of coal gas with which we are particularly interested, and to which I will therefore confine my attention.

Ammonia is produced in the destructive distillation of coal by the union of the nitrogen with the hydrogen—$N + H_3 = NH_3$. The average amount evolved may be taken as 1½ per cent. by volume, or about 480 grains per 100 cubic feet of gas; and by the time the gas has reached the outlet of the condensers, it will contain about 0·70 per cent. by volume or 220 grains per 100 cubic feet of gas—the difference being accounted for by its elimination in the hydraulic main and its absorption in the condensers and cooling mains, by the deposited aqueous vapour previously held in suspension in the hotter gases.

It will therefore be seen that the removal of ammonia commences as soon as the crude gas enters the hydraulic main from the retort, where it comes in contact with the liquor forming the seal. Owing to the temperature at this point being fairly high—from 140° to 150° Fahr.—not so much ammonia is arrested as would be the case if the liquor could be maintained at a lower temperature. But by the time the gas enters the washers and scrubbers, one-third to half the total ammonia it previously contained will have been deposited. Mr. Charles Hunt gives the following results as work done by the various apparatus:—

Ammonia removed by condensation	. . . .	42·7	per cent.
" " in first scrubber	. . . .	43·3	"
" " in second scrubber	. . . .	14·0	"

The removal of the ammonia from coal gas depends upon the solubility of ammonia in water, which, at 60° Fahr. and 30 inches barometer, is capable of absorbing 783 times its own volume of ammonia gas—the amount of absorption increasing as the temperature of the water is lowered, and *vice versâ*. But temperatures lower than 50° Fahr. should not be worked; otherwise the candle power of the gas will be seriously affected. It should, however, be noted that the quantity of ammonia which water will absorb is not entirely dependent upon the temperature of the water, as the solubility takes place directly in proportion to the pressure of the ammonia gas.

If we were dealing with ammonia uncombined with other gases, the whole would be absorbed at normal atmospheric temperature and pressure, to the extent of over 700 times the volume of water employed. But since the gas, as previously pointed out, only contains 0·70 per cent. by volume of ammonia at the inlet to the washers and scrubbers, very little ammonia is dissolved per volume of water, due to the small pressure exerted by the ammonia, though when taken up by the former it is retained owing to the water being at atmospheric pressure. It will now be seen that time-contact between the ammonia and water plays a very important part in the process of ammonia recovery, and should be taken into account when new plant is being designed.

Advantage should be taken of the affinity which ammonia has for combining with, and neutralizing, the carbon dioxide (CO_2) and sulphuretted hydrogen (SH_2) in the crude gas to form carbonate and sulphide of ammonia respectively; the latter in turn being capable of absorbing some of the carbon bisulphide (CS_2), all of which operations are to be desired, as the cost of dry purification is thereby reduced in proportion to the amount of the impurities (CO_2, SH_2, and CS_2) removed in the scrubbers—more especially the CO_2 and the SH_2, for CS_2 at the majority of gas-works is not now specially eliminated beyond what is taken out in the washers and scrubbers, although it is very desirable to keep it below 40 grains per 100 cubic feet.

The following reactions occur when carbon dioxide and sulphuretted hydrogen combine with ammonia in washers and scrubbers.

(1) $2NH_4HO + H_2CO_3 = (NH_4)2CO_3 + 2H_2O$
(2) $NH_4HO + H_2CO_3 = NH_4HCO_3 + H_2O$
(3) $2NH_4HO + SH_2 = (NH_4)2S + 2H_2O$
(4) $NH_4HO + SH_2 = NH_4HS + H_2O$

There is a limit to the amount of work which can be done through the agency of the ammonia, since, as already stated, it is only present in the gas to the extent of 1·5 per cent. by volume. About one-fourth is "fixed" or combined in the ammoniacal liquor as ammonium sulphate, ferrocyanide, chloride, thiocyanate, and thiosulphate, which is useless as a purifying agent for CO_2 and SH_2. Therefore only 1·2 per cent. of NH_3 by volume is left to combine with these two impurities, which are present in the gas to the extent of from 0·9 to 1·5 per cent. of sulphuretted hydrogen and from 1 to 2 per cent. of carbon dioxide—quantities greatly in excess of the amount the ammonia will neutralize.

In order to eliminate from the gas as much as possible of these acid impurities by means of ammoniacal liquor, it is necessary that the gas should be brought into intimate contact with a strong solution of the same; and this can be efficiently carried out in one of the various forms of washers—such as the Livesey, Cockey, "Standard," or Walker washer, in which apparatus the gas is caused to pass through a strong solution of ammoniacal liquor by means of a number of seals, the depth of which may be adjusted according to the make or volume of gas which is to be treated, so that the back-pressure at any time does not exceed 3 inches. In the washer, the gas is divided up into small streams. The contained liquid is consequently agitated by the pressure, and the gas is thereby brought into intimate contact with the same. The washer was one of the earliest forms of apparatus employed for removing ammonia; but owing to ignorance of the principles upon which it should work, it was discarded—partly due to the great amount of back-pressure thrown in some of the older types, and also to the disastrous effect it had upon the candle power of the gas, owing to the latter having to force its way through a tar-seal.

In modern works, all tar should be eliminated in the condensers or in tar-extracting plants—such as the Pelouze and Audouin, the "Cyclone," or other type of extractor—before it enters the ammonia washers, thus leaving the latter free to deal with the ammonia, and consequently increase their efficiency.

An Early Type of Washer.

An early type of washer consisted of a cast-iron rectangular vessel about 3 ft. 6 in. in depth (the length and breadth of which varied according to the required capacity per 24 hours), divided into two sections by means of a plate forming a division or false bottom, fixed about 6 inches from the cover, and drilled with holes about 1 inch diameter, and spaced 3 or 4 inches apart. Into these holes short pieces of gas tubing were fixed, the lower ends of which were sealed in liquor contained in the lower portion of the washer; the depth of seal being regulated by means of a suitable weir-valve. The gas entered the upper division, passed down the 1-inch tubes and through the liquor, agitated the same, and then bubbled to the surface. From this point, it travelled under the division-plate to the outlet, thus coming in contact with the foam that was formed by the gas when bubbling through the liquor-seal.

Anderson's Washer.

This consisted of a cast-iron rectangular outer vessel containing a number of trays, having on their lower side a series of serrated bars arranged at right angles to the flow of gas, and which were sealed in liquor. The gas, having to pass through the serrated bars, was divided up into very fine streams; and being constantly made to dip under the same, it was brought into intimate contact with the liquor. This was a very efficient apparatus; but it has given place to newer and cheaper, though not less efficient, forms of washers.

Young's Washer.

The above washer was designed by the late Mr. Hugh Young, and is still doing good work at the Saltley station of the Birmingham Corporation Gas Department. At these works, the washer consists of three cast-iron rectangular vessels filled with wooden boards, through which the gas is made to pass. Ammoniacal liquor is pumped over the top of each vessel, through which it descends and then overflows to the liquor-well. These washers give no trouble in working, and never get blocked with naphthalene, which is no doubt due to the method of liquor supply adopted, by which system any deposit is readily and quickly washed down to the bottom. They are, however, costly to instal, owing to their great height, and occupy more ground space than modern types of washers designed for dealing with the same quantity of gas.

The Livesey Washer.

This washer was designed by the late Sir George Livesey, and consists of a rectangular cast-iron outer case, the upper portion of which forms the inlet-chamber, and is fitted with one or two outlets according to its capacity—usually two for washers if designed to deal with upwards of 750,000 cubic feet of gas per 24 hours. To the lower portion of the inlet-chamber, specially shaped wrought-iron tubes, having holes 1·20th of an inch in diameter, are fixed; the interior of the tubes being in free communication at the ends with the outlet-chamber. But the spaces between the tubes at the ends are securely closed up. The gas has free access from the inlet-chamber to the intermediate spaces, passing down, and depressing the liquor until the gas escapes through the inclined portion of the perforated plate into the first space, which is filled with liquor, up through which it bubbles, until it comes in contact with the horizontal part of the perforated plate, carrying some of the liquor with it to the upper surface of the same. The bubbles of

gas pass through this liquor into the tube space above, and convert the surface into foam, which flows along with the gas into the outlet-chamber. The washer is provided with suitable overflow pipes, by which the liquor level can be easily adjusted. The inlet liquor-supply pipe is fixed in the lower part of the washer. Glass windows are fitted in the side plates, to enable the bubbling and washing of the gas to be observed. This washer works most effectively when it has nearly an inch of liquor above the perforated plate, which gives about 3 inches of pressure. Special provision is made in the lowest part of the washer for collecting tar, which is separated, and falls by gravity to the bottom; being drawn off independently of the liquor once or twice daily.

This washer has found much favour in gas-works, on account of its great efficiency. Its chief advantages may briefly be stated thus: The minute subdivision of the gas, twice in contact with the liquor. The entire removal of all the tar. The removal of large quantities of carbon dioxide and sulphuretted hydrogen. Facilities for working up the strength of weak liquor. The small amount of attention required. The small ground area occupied. The small cost of foundations. It requires no steam or pumps. It is automatic.

The following are the sizes of Livesey washers to deal efficiently with various quantities of gas per 24 hours.

Quantity of Gas per 24 Hours. Cubic Feet.	Length. ft. in.	Breadth. ft. in.	Depth. ft. in.
100,000	1 3	3 8	2 6
250,000	2 11	4 0	2 6
500,000	3 6	5 0	2 6
750,000	4 0	6 0	3 0
1,000,000	5 0	7 6	3 6
2,000,000	10 0	7 6	3 6
3,000,000	15 0	7 6	3 6
4,000,000	20 0	7 6	3 6

Cathels' Washer.

This arrangement consisted of a series of washers, each complete in itself, placed one above another, the liquor overflowing from the top washer to the second one, and so on in rotation; strong liquor meeting the incoming gas at the lower chamber, and clean water flowing in at the top.

Cockey's Washer.

Cockey's washer in its recent form consists of an upright rectangular cast-iron vessel horizontally partitioned off into three or more chambers. The gas enters the apparatus at the bottom, and travels upward through a vertical pipe, having a cast-iron hood fixed to a horizontal plate over the top. The gas comes in contact with the hood, and then travels downward, and passes through the liquor, after flowing through the four openings in the horizontal plate referred to. Before the gas can free itself from the liquor, it is brought into contact with four or five serrated edged plates forming part of the horizontal plate, the lower ends of which are sealed in liquor. After passing the outer serrated plates, the gas bubbles to the surface of the liquor and passes to the chamber above, where the same washing process is repeated, until at the last chamber the gas leaves the washer by means of an outlet-pipe fixed at the top. The chambers are arranged and constructed so that, after the ammonia is taken up, the liquor is retained in them for a considerable time, and flows downward from chamber to chamber. The free or uncombined ammonia is thus utilized for arresting the carbon dioxide and sulphuretted hydrogen.

By the adoption of the patent overflows, the seals can be regulated in each separate chamber from $\frac{1}{4}$ inch to $2\frac{3}{4}$ inches; and when once set they remain constant until it is found necessary to increase or to decrease the seal. The liquor from each upper chamber overflows into the next lower one, and so on from top to bottom of the apparatus. There are also a series of draw-off taps, by which any upper chamber can be entirely emptied into any lower one, or drawn away from the apparatus without interfering with the passage of the gas. This washer occupies little space, requires no motive power, is continuous, reliable in action, and will work with a minimum of pressure.

Walker's Washer.

This washer is constructed in a similar manner to the Livesey, except in one or two details. It is built up of cast-iron plates, usually made rectangular in form, fitted with the usual tar and liquor overflows and seal regulating valves. The gas-inlet pipe is brought through the bottom plate of the washer, and the gas enters an inlet chamber, from which branch off a number of longitudinal passages or inverted troughs, closed at the far end, but open at the bottom. The lower ends of the inverted troughs are slotted with peculiarly shaped slots, which extend from end to end; and these are sealed in liquor when the washer is at work. The gas passes into the top portion of the troughs above the liquor, forces its way through the slots after displacing the liquor, and bubbles in small streams to the surface and passes away to the outlet.

Kirkham's "Standard" Washer.

The patent "Standard" washer, as manufactured by Messrs. Kirkham, Hulett, and Chandler, consists of a cast-iron vessel fitted with horizontal and vertical division plates, and contains a number of sheet-iron tubes, having their lower ends fitted with perforated inner and outer screens, and their upper ends fitted with machined cast-iron rings and wrought-iron lifting handles; the latter being provided to facilitate the withdrawal of the tubes. The tubes are dropped through faced circular holes, cast in the horizontal divisional plate, and secured to the latter by studs. The lower ends of the tubes are sealed in ammoniacal liquor; and the gas is admitted above the division plate, passes down the tubes and through the perforations in the inner screen, impinges on the outer screen, then passes through the perforations, bubbles through the liquor, and passes away to the outlet. This washer has been found to do its work very well; and although the perforations in the sealed tubes are very small, they are kept perfectly free from choking by the bubbling action which takes place. (See fig. 1.)

Improved "Multiple" Ammonia Washer.

Reference should be made to what is known as the improved "Multiple" ammonia washer recently introduced, and manufactured by the Western Gas Construction Company, of Fort Wayne, U.S.A. (whose English agents are Messrs. W. C. Holmes and Co.). This type of washer is very similar to the Livesey; the main difference being in the position of the "breaking up" or washing perforations in the sealed portion of the horizontal tubes or ducts. The washer consists of a cast-iron rectangular outer case,

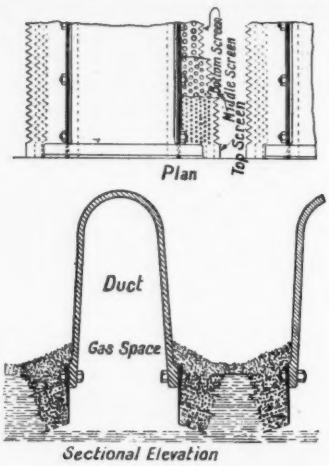


Fig. 2.

to the end plates of which are fixed inverted U tubes, running horizontally. To the lower ends of these tubes three perforated plates are attached, one above the other. Each plate projects a little beyond the one below; but all are bent to the same angle and secured at intervals by bolts to the enlarged ends of the inverted U tubes previously referred to. The perforations in the plates decrease in size and increase in number from the bottom plate upwards; the edges of the plates being serrated from end to end. (See fig. 2.)

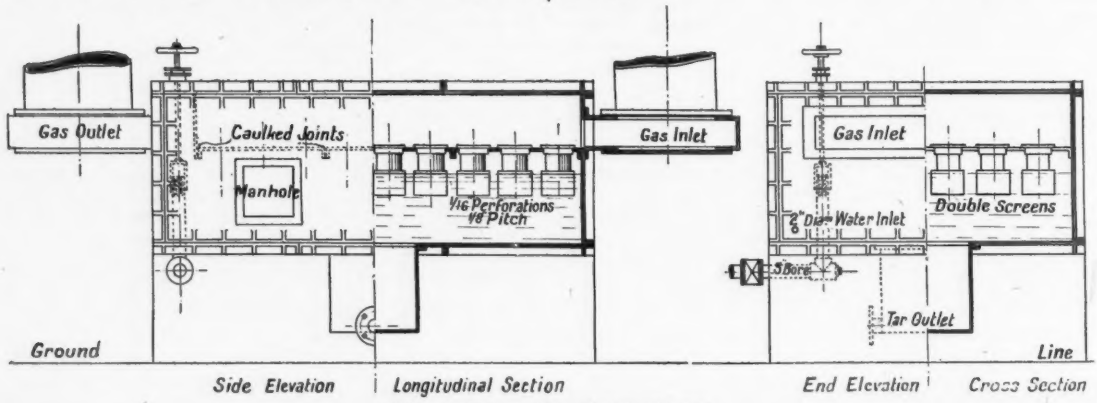


Fig. 1.—Patent "Standard" Washer.

This appears to be a very cheap washer to construct, since no special shaping of the washing plates is necessary, beyond bending them to the angle shown in sketch. Without further particulars as to the working of this form of washer, it would appear that when passing the maximum quantity of gas, all would not find its way through the perforated holes, but take the easier course and pass through the liquor beyond the serrated edges of the plates.

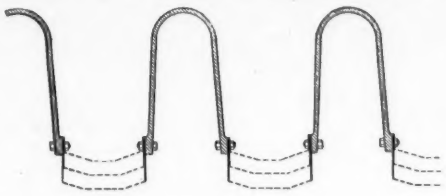


Fig. 3.

From this it would seem to be a better plan to arrange the plates as shown in fig. 3; thus ensuring all the gas being thoroughly subdivided and brought into intimate contact with the washing medium.

Other Types of Washers.

There have been many other types of washers used from time to time, including Charles Hunt's, Good's, Saville's, Dempster's, Whimster's washer and exhauster, &c. Sufficient have been taken, however, to show that the aim in all is to divide the gas into small streams while in contact with ammoniacal liquor; and their efficiency depends entirely upon this, having due regard to the amount of back-pressure which such apparatus will throw.

Scrubbers.

The tower scrubber consists of a cast-iron vessel of considerable height—the usual relationship between the height and diameter being as 7 is to 1—either rectangular or circular in form (the latter shape being preferable), built up in sections and divided into bays. At the bottom of each bay a grid or iron shelf is fixed to suitable brackets cast on the side plates. The shelves support the washing medium, such as coke, drain pipes, wooden blocks, brushwood, or boards which are arranged in the scrubber, and over which liquor is allowed to flow in a downward direction against the upward flow of gas. The object of employing such material for filling is to subject the gas to as large an area of wetted surface as possible. The most efficient scrubber filling undoubtedly consists of wooden boards, about 11 inches in depth, $\frac{3}{8}$-inch to $\frac{5}{8}$-inch thick, spaced from $\frac{1}{2}$-inch to $\frac{3}{4}$-inch apart by distance pieces; the whole being made up in the form of a sieve with the boards set on edge, and the tiers arranged so that each is set crosswise to that immediately below, by which means the gas is very finely divided. At the top of the scrubber, an apparatus is arranged which distributes liquor or water over the scrubbing material. The boards are kept in a very clean condition; scrubbers so filled easily working twice the time any coke-filled scrubber could be expected to work.

The relative areas of wetted surfaces presented to the gas with different fillings are given below; the late Sir George Livesey being the authority for the same:—

Coke	8½	square feet	per cubic foot.
3-inch diameter drain pipes	17	,,	,,
2-inch ,, ,, ,,	21	,,	,,
Boards	31	,,	,,

It will thus be seen that board filling presents practically four times the area of coke filling, though its first cost is naturally higher. But since it can be used over and over again, in the long run it is the cheaper, besides being a more efficient material for scrubbing purposes.

Tower scrubbers are usually worked in pairs; the gas passing through both in succession. The first scrubber is supplied with ammoniacal liquor, and the second, or finishing scrubber with clean water. In small works where only one scrubber is employed, arrangements are sometimes made for the top half to be supplied with water and the lower half with liquor; the gas being brought in contact with strong liquor at the bottom and clean water at the outlet or top portion—thus combining, as far as may be possible, the benefit of a pair of scrubbers.

Scrubber Capacities.

According to the various authorities given below, the capacity of tower scrubbers should be:—

1.—W. R. Chester (1892), Nottingham: Scrubbers and washers, 4·1 cubic feet per 1000 cubic feet maximum make per day. Time contact, 6 minutes.

2.—W. R. Herring (1892), Huddersfield: 9 cubic feet per 1000 cubic feet maximum make per day.

3.—T. Newbigging (1898). 9 cubic feet per 1000 cubic feet maximum make per day.

4.—H. O'Connor (1897). 120 cubic feet per ton of coal carbonized per day (maximum).

5.—V. Wyatt (1887), London: 100 cubic feet per ton of coal carbonized per day (maximum). Time contact, 15 minutes.

The tower scrubber possesses the advantage of being of simple construction (though its great height adds to its cost); and it requires very little motive power, and this only for the water distributors, which should be described before passing along to the apparatus which is better adapted for removing the last traces of ammonia—namely, the rotary washer-scrubber.

Water and Liquor Distributors.

In order to ensure thorough distribution over the whole area of a scrubber, a good distributor must be arranged. One method of supplying a scrubber with liquor or water is that known as Gurney's jet, which consists of a jet under great pressure impinging on a small plate or disc, which causes the water to spread out in a very fine spray.

Barker's mill consists of a pipe which passes through the top of the scrubber, from which radiating pipes pierced with small holes are suspended, and caused to revolve simply by the action of the water pressure—similar to an ordinary lawn sprinkler.

Another arrangement is the well-known tumbler method, which consists of a tumbler constructed to hold a certain quantity of water or liquor which is supplied from an overhead tank. The tumbler is mounted in such a manner that, when filled with the liquor, it overbalances and empties its contents through a sealed pipe, and then returns to its original position. In some tumbler arrangements gear wheels and an index are fixed which register the quantity of water used, and also rotate several radial arms by means of a pawl and ratchet attachment fixed to the tumbler spindle.

In the Mann and Walker type, as made by Messrs. C. & W. Walker, of Donnington, a brushwood wheel is fixed in the top of the scrubber, which is caused to revolve by means of bevel wheels worked from a vertical shaft attached by means of brackets to the outside of the plates forming the scrubber, and worked by a small steam-engine fixed at the scrubber base. Water or liquor from an overhead tank is supplied through funnels and down-pipes and sprayed over the brushwood wheel by means of revolving distributors, which work eccentrically, travelling rapidly when nearing the centre and slowly when traversing the outer circumference, consequently causing the liquor or water to be dashed or sprayed all over the brushwood. Such an arrangement is at work on the 15 feet and 20 feet diameter scrubbers at the Saltley works, and, beyond daily regulation of the water flow, require very little attention.

Three distributors are fixed in each of the appliances referred to. The liquor overflows at the bottom of the scrubbers through the ordinary seal-pot arrangement. If liquor is employed, care should be taken to have the overhead liquor tanks perfectly air-tight, to prevent loss of ammonia through evaporation and agitation. The temperatures should be controlled and maintained as near as possible at 60° Fahr. Where deep well water is available, it is an advantage to use this in the summer months, as its temperature will, in all probability, be found to be lower than that of the town supply (this has been my experience). At the Saltley works, well water is employed in the summer on the finishing scrubber, and town water in the winter months. Well water would be used all the year round for economical reasons. But trouble has been experienced with incrustation or precipitation owing to the softening action of the ammonia; hence the reason for not employing it for longer periods. There is, however, a decided advantage in using it in summer, on account of its greater power for absorbing ammonia, due to its low temperature.

Rotary Washer-Scrubbers.

A very simple and efficient mechanical washer-scrubber was that known as the Anderson scrubber, which consisted of a vertical tower, divided into separate compartments, in each of which a drum of whalebone fibre was fitted and revolved by suitable gearing. The drums exactly fitted the spaces allotted to them, and, when revolved, dipped into the liquor contained in the several compartments of the scrubbers, while the gas passed through the wetted fibres and escaped from a lower to a higher compartment through an uptake fitted to the side plates, where it met another brush which revolved in the opposite direction to the one in the compartment below. This scrubber was fitted with a washer at the base. It was a very simple arrangement, and was improved upon by a Mr. Creeke, of Messrs. Henry Balfour and Co., of Leven, Fife.

Creeke's Annular Brush Scrubber.

When first put on the market Creeke's brush scrubber consisted of two or more steel cylinders with closed ends, placed horizontally and arranged one above the other. Each was provided with a gas-inlet port at the centre and one end, while, at a lower level, and on either side of the inlet, were provided two outlet ports. These outlets in the lower cylinder communicated, by means of suitable connecting pipes, with the inlet of the cylinder immediately above. In each of the cylinders a compound or annular brush was fitted, formed with a cast-iron ring at either end and secured to a central shaft carried on suitable bearings at the end. The rings had two ledges—one at the outer circumference, the other at a suitable distance towards the centre—to which wooden staves were secured, and which, in turn, carried the fibrous scrubbing material; thus forming two cylindrical brushes, one inside the other. The annular space between the brushes was in direct communication with the inlet port at the end of the containing cylinder. The other end of the annular space was left open; but both ends of the drum on which the inner brush was fixed were closed gas-tight.

The apparatus operated as follows: From the inlet, the gas

passed along through the inner annular space, escaping at the end, whence it returned along the surface of the outer brush, through the annular space, and down to the outlet-ports, and so was conducted to the inlet of the brush immediately above it, where it passed along the annular space, and so on over the outer brush to the outlets, as before, until finally leaving the scrubber at the main outlet. Each cylinder was filled with liquor up to the level of the inlet-mouths of the inner brushes, which acted as overflows, allowing it to run in rotation from the top to the bottom brush. The brushes revolved in the liquor, and were constantly presenting wetted surfaces to the gas. The foul gas entered the bottom of the first cylinder, was met with the strongest liquor and brought in contact with clean water at the top cylinder. In the early type described, the brushes were revolved by means of Ley's patent chain gearing; and the lower brush made two revolutions to each revolution of the upper brushes. Since its early days, this scrubber has been considerably modified; and in those made to-day, the gas passes up a casing at one end of the vessel, instead of through pipes leading from the outlet-ports previously referred to, and bevel-gearing has taken the place of the chain-drive. I have entered into a rather full description of this apparatus, since it is really a modern adaptation of the first rotary washer-scrubber as introduced by Mr. George Anderson, and which is still capable of doing good work.

The following shows the results of several tests on a brush-scrubber of this description, dealing with 800,000 cubic feet of gas per 24 hours, from which it will be seen that strong liquor can be produced and the gas entirely freed from ammonia.

Gallons of Water per Ton of Coal Carbonized.

Division.	12 Galls. Oz.	11 Galls. Oz.	10 Galls. Oz.	
In washer. . . .	13·8	16·0	18·0	Percentage efficiency for ammonia, sulphuretted hydrogen, and carbon dioxide not tested; but clean tests with litmus and turmeric papers were obtained.
1st brush	11·8	14·0	15·2	
2nd ,, ...	4·3	5·4	7·4	
3rd ,, ...	1·1	2·2	3·0	
4th ,, ...	·3	·4	·8	
5th ,, ...	—	—	·1	

Fig. 4 shows one complete cylinder, from which it will be noticed that additional cylinders may be easily added when required.

Laycock and Clapham's "Eclipse" Washer-Scrubber.

This washer-scrubber is of the horizontal rotary type; the previous mechanical washer-scrubbers described being vertical. The "Eclipse" washer-scrubber is made by Messrs. Clapham Bros., of Keighley, and consists of a cast-iron vessel with semi-circular top, built up in segments; the bottom portion of the vessel being divided into internal chambers by cast-iron plates, in which cylinders keyed to a steel shaft running from end to end of the apparatus revolve. The shaft is carried on bearings fixed on each end plate, and by other bearings fixed to the division-plates forming the chambers. The outer edges of the cylinders are faced and run against similar facings inside the case, which prevents slip of gas from one chamber to another, and compels the gas to pass through the cylinders, which are filled with wood balls about 1¼ to 2 inches diameter (depending upon the capacity of the machine), bored with a ½-inch hole in the centre.

These balls are continually wetted with liquor, which is picked up from the bottom part of the washer by perforated buckets fixed to the peripheries of the revolving chambers in one make of washer, while in another type the liquor passes through openings in the side plate of the revolving drums, thus ensuring a constant wetted washing area being presented to the gas. The weak part about washers of this description is the liability of slip of gas taking place; and the makers of the "Eclipse" got over this difficulty by fitting a tail-pin to keep the facings of the revolving cylinders in contact with the case. The washer may be driven in any ordinary way—belt driven or direct driven—but in machines of recent make worm-gearing enclosed in a cast-iron box is fitted, being direct driven by a specially designed small engine, mounted on the same bedplate. I am informed that an "Eclipse" machine has been in constant work since the year 1891, and has not cost a penny for repairs, which speaks well for the quality of material and workmanship employed.

I might mention at this point, and to save repetition, that it is usual in the rotary types of washer-scrubbers to supply them with clean water at the gas-outlet end, which, after entering the washer, overflows from chamber to chamber, gradually getting stronger and stronger, and overflows at the end where the gas enters the apparatus. These washer-scrubbers are also fitted

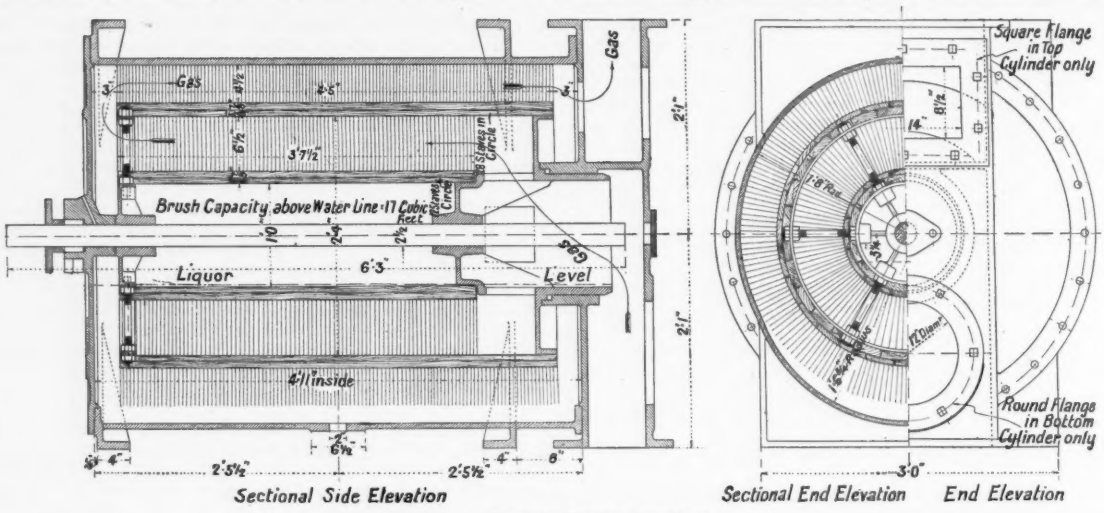


Fig. 4.—Creeke's Washer-Scrubber.

with "draw-off" or sludge cocks, and in some cases with hydrometers under glass cases to enable the strength of the overflow liquor to be noted.

Holmes and Co.'s "New" Washer-Scrubber.

This is another type of horizontal rotary washer-scrubber, and consists of a cylindrical outer case composed of cast-iron plates, divided into separate chambers, as in the "Eclipse" washer-scrubber, by means of vertical cast-iron plates; each chamber containing ammoniacal liquor as before. Inside, a number of ¼ inch wrought-iron plates are ranged, fixed alternately between the flanges of the cylinders and to the driving shaft running from end to end of the apparatus. This shaft is supported on brackets carrying bearings outside each end plate, and by another in the centre of the washer-scrubber carried on a cast-iron standard in the older types. But in recent machines an outside bearing is arranged, the washer being made in two halves and connected together with a gas connecting-piece. The advantage of the outside bearings will be obvious. To the iron plates attached to the shaft, and referred to above, circular brushes are fixed, which dip into the liquor in the lower portion of the washer and revolve with the shaft, and constantly supply freshly wetted surfaces to the gas, through which brushwood the gas has to pass before it reaches the outlet. These brushes contain an enormous area of washing surface, and occupy a very small space. The cost of the brushes for renewal is, however, somewhat heavy; but this is of small account with so efficient an apparatus (99 per cent. efficiency). The method adopted in this washer-scrubber to prevent "slip" is to set the brushes to give a ¼-inch thrust on each of the division-plates. Between the washing-chambers, in some of the designs of this washer-scrubber, are annular spaces, which the makers say enable the liquid to be worked up to a greater strength. These spaces are known as "still" chambers.

Messrs. Holmes also make a vertical rotary scrubber-washer for works where ground space is a consideration. This is very similar to the Anderson type, and need not take up any more of our time.

Walker's Purifying Machine.

This machine as made by Messrs. C. & W. Walker, Limited, of Donnington, differs entirely from all other ammonia washing plants. It consists of a rectangular cast-iron vessel and in some cases is fitted with a washer of Walker's design in the lower part. This washer has previously been described.

After leaving the washer, the gas enters the "purifying machine" proper, which is built up of six chambers, in which movable wooden boxes, or what the makers term "devices" are attached to vertical shafts, connected to rocking beams at the top of the machine, which are worked by an outside vertical shaft and bevel-gearing, and driven by a small horizonal steam-engine usually fixed at the ground level. The gas travels from one chamber to another between the constantly wetted boards forming the devices, which dip into the liquor at one stroke of the rocking beam, and on the return stroke are pulled up from the same to come into contact with the gas.

Clean water is admitted at the top of the machine, and flows downward from chamber to chamber, finally overflowing as a strong ammoniacal liquor. Such arrangement is adopted when

the machine is employed as a finishing washer or scrubber; but when followed by another washing or scrubbing apparatus, liquor should be used in place of the water. Such is the arrangement at Saltley, where in one section of the works a Walker purifying machine, dealing with 5 million cubic feet per day, precedes a 20 feet diameter tower scrubber, and deals with gas which has previously been treated in a Young washer.

The power required for driving the necessary gearing is small. The machine works very efficiently, and requires little attention beyond the daily running off of any tar which may have been arrested, adjusting the seals, and regulating the water or liquor used.

The whole arrangement of washing devices, gearing, &c., is thoroughly illustrated in fig. 5, and calls for no further remarks

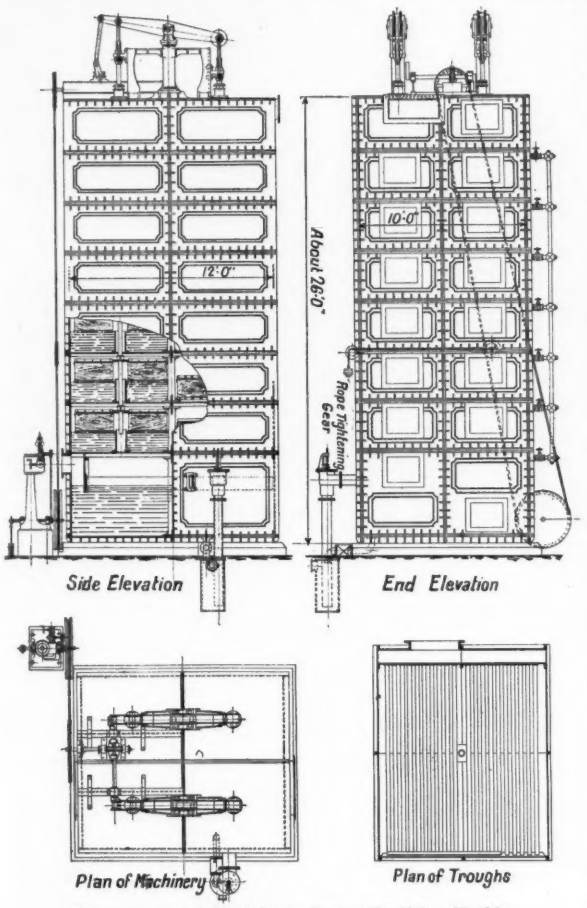


Fig. 5.—C. and W. Walker's Patent Purifying Machine.

here, beyond saying that rope-driving arrangements are shown in this case.

The Whessoe Rotary Washer-Scrubber.

This washer-scrubber consists of a cylindrical outer vessel, divided into separate chambers as described in the other rotary types, fitted with a horizontal shaft carried in suitable end plates and internal bearings; the shaft being fitted with washing devices or bundles built up in segmental clusters of sheet steel (or thin boards if preferred) and the spaces maintained by wooden washers or distance-pieces—the bundles held taut and rigid by bolts securing them to the sheet-iron side plates of the washing drum. In this washer-scrubber, the end plates are made ⊐ shaped, and extend the whole length of the pier. This affords great rigidity, and prevents side rock or oscillation, and dispenses with cradles. The provision made for the connections might be specially mentioned. It consists of a cast-iron box bolted to the end plate, through which the driving shaft passes, suitably carried in a stuffing-box. The side, top, and bottom plates of the "universal connection box" referred to are cast with holes, so that the connections may be made in any of these positions; blank flanges being provided for the remaining plates. This is a great convenience and does away with bends, which are liable to become choked with naphthalene. The connections may, however, be arranged without the universal connection box.

A recent Whessoe improvement consists of a central driving arrangement of spur-gearing direct driven; all bearings being in sight, and the washer-scrubber compartments arranged on the twin method—namely, isolated, and connected with gas-way connecting pipes. The advantages claimed for this method of driving are: (1) Reduced cost of shaft—being central driven, is subjected to less tension, and therefore can be of smaller diameter. (2) Central instead of end strain. (3) Liability of breakdown reduced by 50 per cent. (4) Cost of repairs reduced by 50 per cent. (5) One half of the machine available for work while the other half is under repair, if connections are so arranged. (6) Exposed bearings.

Kirkham's "Standard" Washer-Scrubber.

The earlier make of this type of machine consisted of a ⊐ shaped cast-iron tank containing several water compartments, in each of which metal discs were caused to revolve. The discs were made up to about sixty in number in each compartment, fitted together in the form of a sheaf. The surfaces of the discs were indented to a depth of an eighth of an inch, in order to present roughened surfaces to the gas and keep the discs apart, or, in other words, to act as distance-pieces. Each sheaf of discs was suspended from a central shaft supported in the usual manner, the lower portion being immersed in the liquor, the remainder of the apparatus being practically as it is known at the present time. After some little time, the metal discs were discarded and wooden bundles substituted; the efficiency of the machine being considerably increased. The chief advantages claimed for the new arrangement were: (1) The driving shaft of the washer-scrubber greatly relieved of weight. (2) Less wear and tear. (3) Smaller driving power required. (4) Washing surfaces kept cleaner and free from deposit.

The improved "Standard" washer-scrubber as manufactured to-day is much in advance of the older machine; many important improvements having recently been introduced. It consists of a cylindrical horizontal vessel divided into compartments by vertical division plates, having circular openings in the centre through which the gas passes from one compartment to another, after being washed or scrubbed by the revolving wooden bundles referred to above. The scrubbing bundles consist of wooden boards $\frac{1}{8}$-inch thick, spaced about $\frac{3}{16}$-inch apart by distance-pieces attached to a light wrought-iron frame; the whole being secured to the shaft by a key driven in a cast-iron collar.

The effectiveness of this washer-scrubber depends to a great extent upon the faced joints between the revolving collars and the division plates. The recent machines are made in two halves, connected by a gas connecting main. All bearings are arranged for easy access; and the washing bundles may be obtained in different patterns to suit all conditions of working. One arrangement, which is recommended, is in the form of corrugated wrought-iron sheets, the corrugations of alternate sheets crossing each other. This arrangement provides the maximum amount of washing surface for "bundle" washers. The gas is very thoroughly split up, it zig-zags between the corrugations, and the water is thoroughly distributed.

Another important improvement is to be found in the driving arrangement; the engine being bolted to the end plate of the washer-scrubber, directly coupled by means of a worm and worm-wheel to the washer shaft. With this method of driving, ground space and cost of engine foundations are saved; also silent running is ensured. I had experience with one of the first washer-scrubbers of this new design which was erected at Bath, where it is used as a finishing scrubber, dealing with 3 million cubic feet of gas per twenty-four hours, after it has passed through three vertical or tower scrubbers. It is worked at the "maximum make" period; the connections being so arranged as to enable the gas to be put through a Cockey washer during the "minimum make" period, and so allow first one and then the other to be let-down for cleaning, which process enables all washers, scrubbers, or washer-scrubbers to be maintained in a thoroughly efficient manner. This is of the utmost importance if every advantage is to be taken in the recovery of ammonia to swell the revenue account by this bye-product. A study of the workings of the various gas undertakings shows a very considerable difference in the returns for ammonia in the form of ammoniacal liquor, concentrated ammoniacal liquor, or sulphate of ammonia—the three principal forms into which the ammonia is converted in gas-works.

Some undertakings only receive $\frac{3}{4}$d. and even less for ammonia products per 1000 cubic feet of gas sold, while others obtain nearly 4d., showing the necessity for some levelling-up. There are, of course, matters which enter into the great difference in the returns shown—such as the amount of ammonia evolved from various kinds of coal carbonized, wages paid for labour in the different districts (which varies considerably), and also the strength to which the liquor is worked up. It should here be stated that the receipts from ammonia products, as well as those for other residuals, in undertakings manufacturing water gas are obviously lower per 1000 cubic feet of gas sold than in those manufacturing coal gas only, and are therefore not comparable; but the figures quoted above apply to works manufacturing coal gas only.

Chandler's Double-Action Rotary Washer-Scrubber.

Another, and recently patented, apparatus is that known as S. B. Chandler's double-action rotary washer-scrubber. This is very similar to other rotary machines. The principal difference is in the washing bundles, which, in this case, consist of several thin iron plates punched all over with small holes; the edges being left in a ragged condition. The plates are bolted together with distance-pieces between them in the usual manner. The holes are punched in the plates on the "hit-and-miss" principle; alternate plates having the perforations in the same position. By this means, the gas is made to pass through the bundles in a more or less zig-zag course, and is brought in contact with a very great area of wetted surface. The idea is a good one; but I am under the impression that such bundles would quickly make-up with naphthalene, and be rather difficult to clear excepting by

excessive steaming. This is to be avoided, since ammonia would be liberated and driven forward.

I have now dealt with all the well-known and tried types of washers, scrubbers, and washer-scrubbers; but this paper would not be complete if reference were not made to new appliances from which much is expected in the future, both as regards first cost and working efficiency.

Centrifugal and Other Types of Washers and Scrubbers.

There yet remain four other washers or scrubbers to which reference must be made—namely, the Feld vertical centrifugal, the Kirkham vertical centrifugal, the Liversedge centrifugal, and Burstall's gas-washer, which will be taken in the order named.

Feld's Centrifugal Washer.

This washer is different in every respect from those previously described, and is the invention of a German chemist—Dr. Feld. It is manufactured by Messrs. R. & J. Dempster, Limited.

The details of the design and arrangement of the apparatus are shown in the drawing,* from which it will be seen that it is of the vertical type, made up of a number of cast-iron chambers or sections of similar construction, cylindrical in form, each fixed one above the other, the number of chambers varying according to the required washing capacity. A central shaft is fitted vertically, working in roller bearings, and supported at the bottom of the washer by suitable cast-iron brackets, driven by bevel wheels keyed to the lower end and to a horizontal driving shaft, as shown, or by fast-and-loose pulleys. In fact, any ordinary arrangement of drive may be employed. The power required for driving is very small—a washer capable of dealing with 1 million cubic feet of gas per 24 hours only requiring a 2-H.P. engine. To the central shaft sets of cones are keyed, each set consisting of six to twelve plates placed one inside the other—one set to each chamber or section. The lower ends of the cones dip into the dish-shaped casting containing the washing fluid-water or ammoniacal liquor. In the latest design, only four cones make up a set; the outer one being slotted and somewhat deeper than the others, by which a better spray is obtained. Four or more openings are arranged in the dish-shaped liquor containers, through which the gas may pass upward from chamber to chamber against the downward flow of excess liquor on its way to the outlet.

When the washer is in action, the central shaft, with the attached sets of cones, driven at the rate of 120 revolutions per minute, causes the liquor to be drawn up on the inside of the cones from the liquor containers, and thrown off at a tangent at the upper edges with great velocity across the gas-ways and against the chamber walls in the form of a thin spray or sheet of liquor; and it is through this that the gas has to pass, and by this it is washed. It will be seen that the gas and water are brought into contact with each other in such a way that very thorough washing is ensured, not merely by bringing the gas in contact with wetted areas as in the horizontal rotary type of washer, but by actually passing the gas through a thin sheet of water or liquor; and this is done without an increase of back-pressure—certainly not more than $\frac{1}{2}$-inch. A baffle or screening plate is fixed in the top of the washer to prevent the spray being carried over; thus allowing the gas to pass away in a dry state.

The advantages claimed for this new washer are set out by the patentee as follows: (1) Most intimate mixture of gas and washing liquid. (2) Highest possible efficiency, owing to exceedingly fine diffusion of washing liquid due to centrifugal force. (3) Throws practically no back-pressure. (4) Lowest volume of washing medium required. (5) Concentrated liquors are obtained. (6) No clogging, even when working with muddy solutions. (7) Simple operation. (8) Small power required to drive. (9) Small space required. (10) Can be constructed of practically any capacity. It is very compact. Therefore its first cost is low compared with other forms of scrubbers.

The dimensions of a washer designed to deal with 7 million cubic feet of gas per twenty-four hours in six chambers are only 26 ft. $1\frac{1}{2}$ in. high by 6 ft. 3 in. diameter. Such a washer is in use at Saltley, and has been running for two years; the cost of repairs being *nil*. The washer is employed for the extraction of cyanogen; but tests have been made to obtain its efficiency for ammonia extraction, which comes out at 99 per cent., making a 6 oz. liquor. No doubt much better results could have been obtained if arrangements had existed for pumping the liquor over and over in the lower divisions, and admitting fresh water to the top or finishing position, or if two washers had been worked in series to produce a stronger liquor. This, however, was not possible. But I think the tests will prove the efficiency of the washer, which no doubt has a great future before it, and may possibly revolutionize the existing methods of gas purification and bye-products recovery. In fact, a plant on the Feld principle has already been put to work at the East Hull Gas-Works for the extraction of sulphuretted hydrogen from coal gas; the active agent employed in the washers being zinc thiosulphate solution, which is made in the first instance by the action of sulphur dioxide on zinc sulphide formed from zinc oxide and sulphuretted hydrogen. Two Feld washers are used in this system, and the reactions which take place are as follows:—

$$2ZnS + 3\,SO_2 = 2ZnS_2O_3 + S$$
$$2ZnS_2O_3 + 6H_2S = 2ZnS + 6H_2O + 8S.$$

Even further advance is proposed; Dr. Feld being at present engaged in perfecting a process by which ammonia is to be removed from gases and converted into ammonium sulphate simultaneously with the removal of sulphuretted hydrogen. If this is found to be an efficient system, the days of the dry purifier will be short. Ammonia and sulphuretted hydrogen, the only impurities (not including naphthalene) which have to be eliminated (since the disappearance of the sulphur clauses), will then be dealt with in the same plant, the advantages of which will be obvious. These matters have been mentioned to show the possibilities of the Feld washer; but further cannot be said at present as no working results are available.

* This is similar to those given in the "Journal" in 1908—see numbers for July 21, p. 161, and July 28, p. 228.

Kirkham's "Standard" Centrifugal Washer.

This machine is very similar in its action to the Feld washer described above. It consists of a vertical cylindrical cast-iron vessel divided into a number of chambers, fitted with a central vertical shaft to which are attached spraying devices for lifting and spraying the ammoniacal liquor or water used as a washing medium; bringing it into intimate contact with the gas. The

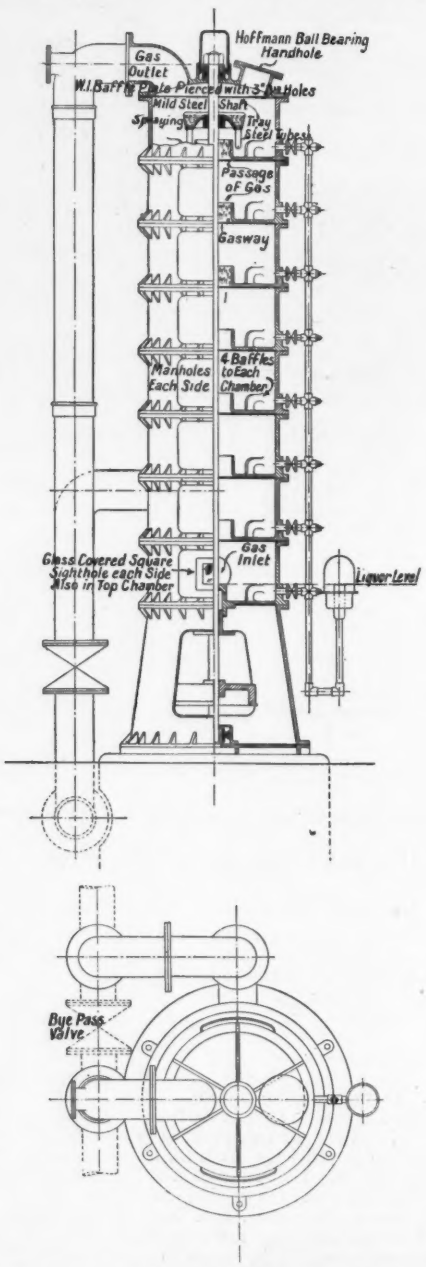


Fig. 6.—Patent "Standard" Centrifugal Washer.

devices consist of specially-designed trays having perforated rims and bent tubes (usually four in number) depending from their undersides. The trays are made in halves to facilitate taking apart for cleaning if found necessary (see fig. 6).

The shaft and trays are revolved at a speed of 100 to 150 revolutions per minute, according to the diameter of the apparatus. As the devices revolve, the liquor is picked up by the bent tubes, carried into the trays and through the perforated rims, across the gas space to the plates forming the shell of the washer, rebounding and falling to the liquor container, from which it overflows finally leaving the apparatus at the bottom chamber. The gas ente-s at

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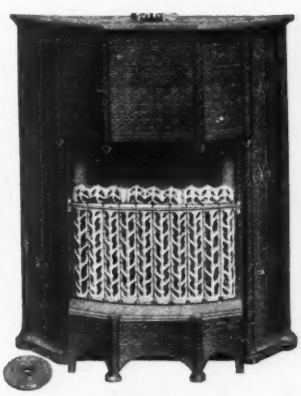

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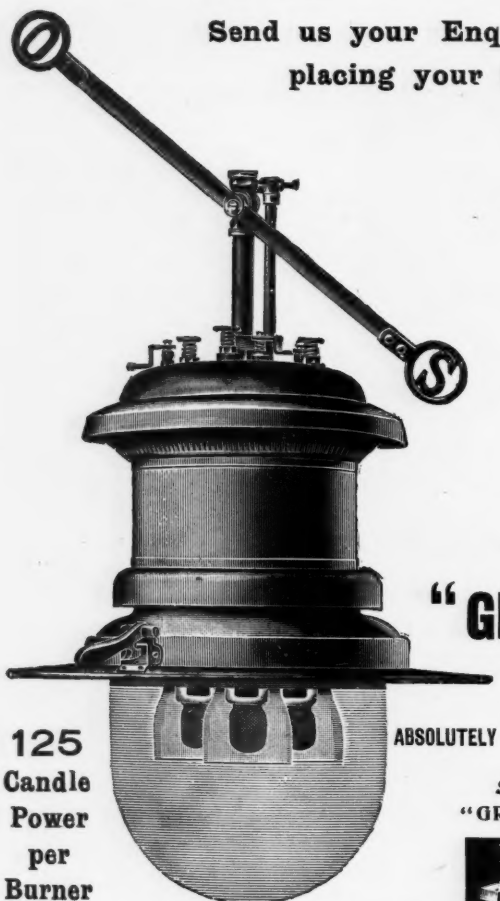

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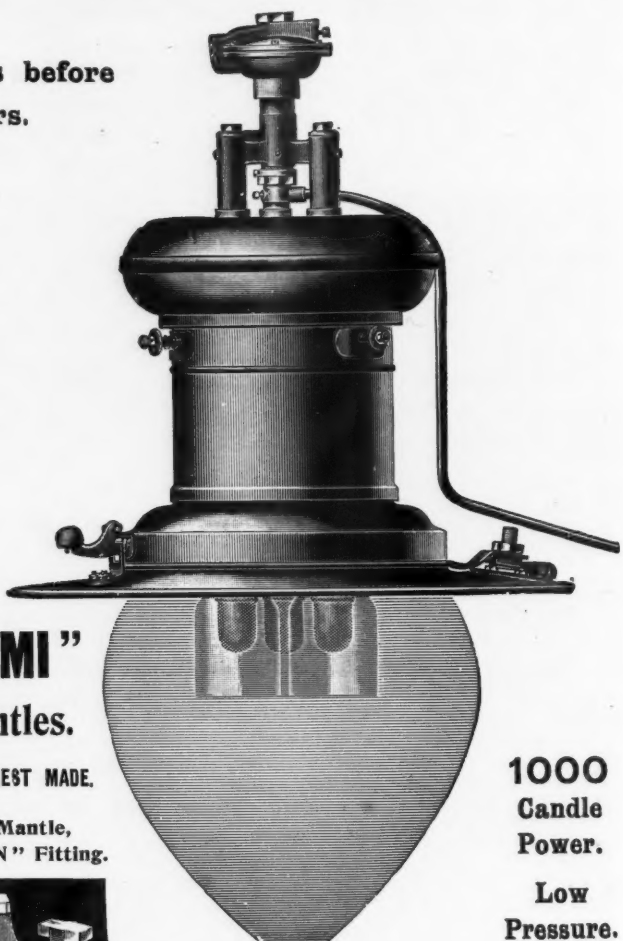

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the base and flows upwards from chamber to chamber through the central openings and through the spray, finally leaving at the top. The liquor is admitted at the top and flows downward through the central openings.

It is a very simple washer, requires little or no attention, the driving power necessary is small, its first cost is low compared with ordinary scrubbers, and a great saving in ground space can be effected by its adoption. A washer designed to deal with 500,000 cubic feet of gas per twenty-four hours, working at the Hitchin Gas-Works, is only 3 feet in diameter by 17 feet high over all.

Burstall's Washer.

This apparatus, which is a recent invention of Professor Burstall, of the Birmingham University, and which I was recently kindly allowed to inspect, is of very simple construction, very compact, and surprisingly small for dealing with any given quantity of gas per hour. The washer is mechanical, and consists of a cylindrical outer case fitted with a horizontal central driving shaft to which perforated plates are attached, and which are revolved at about fifty revolutions per minute. The end plates are fitted with the usual inlet and outlet pipes for gas and liquor. The perforations in alternate plates are arranged at the centre and at the periphery respectively, and about $\frac{1}{8}$-inch clearance is allowed between the edges of the plates and the casing of the washer. The seal is secured by the centrifugal action of the revolving plates on the liquor contained in the washer; and slip of gas is rendered impossible. From the inlet the gas is made to pass through the washer in zig-zag fashion, flowing through a central perforation in one plate, then rising to the top portion to pass through another opening in the next plate, to again descend and rise between the plates until the outlet is reached—being brought into contact with wetted surfaces and consequently cooled and washed.

Professor Burstall explains that, when washing ammonia from coal gas, it would be advisable to employ two such washers in series, and utilize them not only for washing but also for condensing purposes. The gas at the outlet of the first washer would probably be reduced to about 80° Fahr., and to 60° Fahr. in the second one. The liquor leaving No. 2 washer would flow into a bosh, from which it would be pumped and circulated through No. 1 washer, and the hot liquor from No. 1 pumped into an atmospheric condenser, from which it would flow to No. 2 washer, until it attained any predetermined strength, when it would be run off to the storage well and a supply of clean water admitted to take its place.

A washer to deal with 30,000 cubic feet of gas per hour would have the following dimensions: 3 ft. 6 in. diameter by 3 ft. 6 in. long, or about 5 feet long including bearings and supporting standards.

Burstall's "Static" Washer (Non-Mechanical).

Professor Burstall has now invented a non-mechanical washer, designed in the first case to cool the gas and recover the tar. With some slight modification, this has been recently installed in a gas-works to recover ammonia. The washer consists of a rectangular steel tank, fitted with a dished bottom and supported upon a light framework, as shown in fig. 7. The gas inlet and outlet connections are arranged in the end plates, and the overflow liquor taken from the deeper end of the washer. The washer is 3 ft. 4 in. deep at one end and 3 ft. 7 in. deep at the other, to which end the tar flows, and from which it is drawn off. Under the top cover plate, and spanning across the washer, a number of $\frac{13}{16}$-inch by $\frac{13}{16}$-inch inverted steel channels are supported by the side plates, as shown in the enlarged cross section. Into the channels wires are cast (the wires are placed into position in the channels before the latter are fixed and molten lead run in) and the channels closed in between the wires, as shown in dotted lines on the drawing. The number of wires in each channel or section number 58 and 59 alternately, and are arranged in the sections so that those in one section come opposite spaces in the next section (see detail). The number of sections in the washer shown, which has been designed to deal with 50,000 cubic feet per hour, is 117.

Around the top of the washer water-supply pipes are fitted, whence several branches are taken and carried internally across the washer. Holes, $\frac{1}{16}$ inch in diameter by $\frac{1}{4}$ inch pitch, are pierced in the cross water-tubes in the positions shown; and as the water is supplied at a fair pressure, jets of water are caused to impinge upon the wires, and form thin sheets, through which the gas is made to pass, and is also brought into contact with the large number of wetted wires (about 6780) contained in the washer. When used for ammonia recovery, the apparatus is divided into a number of separate compartments connected by gas-passages, and the liquor is caused to pass from one to the other, by means of a small pump, becoming stronger in ammonia as it passes through the washer.

I have no figures as to the efficiency of this apparatus; but by the time this paper is read, perhaps Professor Burstall may be able to supply the same. The advantages claimed for this washer are: (1) It has no moving parts. (2) It is very compact. (3) It does not clog with tar.

The illustration shows a washer designed to extract tar; but it will serve to show the general arrangement of the ammonia washer.

Burkheiser's Washing Process.

I would like to draw your attention to a recently patented process which appears to me to have a great future before it. I refer to Burkheiser's process for purifying and washing gases, in which it is intended to (1) absorb sulphuretted hydrogen by means of ferric hydrate; (2) revivify the fouled material and form sulphur dioxide; (3) form ammonium bisulphite from the sulphur dioxide and a solution of ammonium sulphite; (4) form ammonium sulphite by the taking up of ammonia by the solution of ammonium bisulphite; (5) the oxidation of the ammonium sulphite to ammonium sulphate. Further particulars cannot be given here; but a full description of this important process may be found in a recent issue of the "Journal of Gas Lighting," to which I would draw your attention.*

Weekly tests on the outlet of the finishing scrubbers should be taken for the amount of ammonia passing in grains per 100 cubic feet of gas, and the amount calculated as so much 10-oz. liquor lost, to enable comparisons to be made of the working over any extended period. This method is to be preferred to that which simply shows the ammonia which is not eliminated; for this does not take into account the quantity of gas dealt with, and therefore the quantity of ammonia lost for comparative purposes.

The calculation is made as follows:

$$\frac{\text{Make of gas for week}}{100} \times \text{loss of } NH_3 \text{ in grains} = \text{total grains of } NH_3 \text{ lost.}$$

$$\therefore \frac{\text{Total grains of } NH_3 \text{ lost}}{1522 \text{ (grains } NH_3 \text{ in 1 gallon of 10 oz. liquor)}} = \text{quantity of 10-oz. liquor lost in gallons.}$$

The recovery of ammonia and its conversion into ammonium sulphate in the same apparatus appears to me to be the next

* See "Journal" for Oct. 4, 1910 (p. 23).

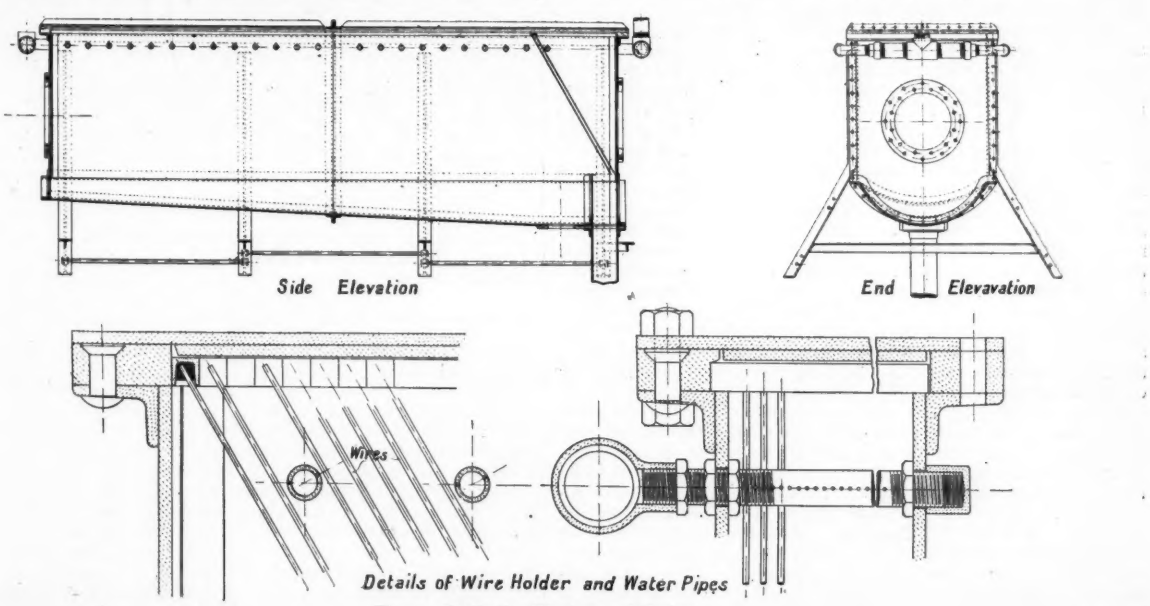


Fig. 7.—Static Gas Washer and Cooler.

advance in gas-works economies, by which a saving of as much as £2 per ton of sulphate made should be obtained, thus—

Fuel	£0	10	0
Manufacturing wages	0	6	0
Stores (manufacture)	0	0	3
Stores (repairs)	0	12	0
Wages (repairs)	0	7	0
	£1	15	3

To this must be added the saving in interest and redemption on the lower capital expenditure on plant; making roughly a saving of £2 per ton of sulphate produced. This is practically a 50 per cent. lower producing cost than is obtained with the most efficient sulphate plants at the present time.

BRICK, CONCRETE, AND STEEL TANKS FOR GASHOLDERS.

By Herbert W. Alrich.

[A Paper presented to the American Gas Institute, October, 1910.]

(*Concluded from p.* 403.)

It is interesting to observe that the investigators have confined their attention to the security of the tank against being overturned bodily. As a matter of fact, this does not concern us at all, and is impossible under operating conditions. The actual task is to build a water-tight tank, and no peril of collapse confronts us. Retaining walls of the usual proportions, resting upon earth, are generally found to lean outward in attaining their maximum stability. With other than very firm soil formations, this leaning must occur if the wall is to develop its maximum resistance. Hence if a tank be assumed to consist of a series of retaining walls, it is evident that the elements could lean outward and be stable, but the tank would not be tight. As long as the tensional resistance in the masonry bond between the elements prevents leaning, there can be no retaining wall action. When this tensional resistance has been overcome, the elements will be stable, but the useful career of the tank has ended.

In providing external assistance for the masonry, the first resort is naturally to the surrounding earth. The particular assistance required is that which will prevent the wall from cracking. The extent to which such assistance may be derived from the backing is obviously dependent upon the character of the formation. All geological formations lie between two extremes of condition—fluid and monolithic. The vertical pressure against a horizontal plane at a given depth below the surface of a column of fluid is equal to the weight of the fluid above that plane. The horizontal pressure against a vertical plane of unit area at the same depth as before is likewise equal to the weight of fluid above. If the position of the vertical plane remains unchanged, the pressure against it will also remain unchanged. This is the condition of passive pressure. If the plane recedes, the fluid will follow; and pressure against the plane will continue. This property of following a yielding resistance is active pressure. If the plane be advanced towards the fluid, the pressure against it will still continue—this being the condition of bearing pressure.

The vertical pressure against a horizontal plane at a given depth below the top of a mass of rock is equal to the weight of the rock above; but because of the relative incompressibility and inelasticity of stone, there is neither active nor passive pressure against a vertical plane. Hence, the only pressure rock can exert against a vertical plane is the bearing pressure developed by advancing the plane against the rock.

The behaviour of all earth formations lies between that of fluids and that of rock. While the behaviour of any particular ground cannot be foretold with much accuracy, it is somewhat consistent with the extent to which the physical condition approaches one limit or the other. If a masonry tank be surrounded by earth in a plastic condition, the internal hydrostatic pressure will be largely balanced by the active external pressure; and the expansion of the tank's diameter will be reduced below that where cracking would occur. If the tank be built in an excavation in rock, the backfill may be so puddled as to transmit the internal hydrostatic pressure directly to the rock. In this case, also, no cracking would be apprehended. If, however, the earth surrounding the tank be somewhat firm in character or consist of damp sand or an elastic clay, it will probably be capable of exerting little passive pressure and no active pressure. With such formations, it will not avail to build up a thrust by compacting the backfill around the tank, as any such pressure in excess of that of which the earth behind the backfill is inherently capable, is artificial and cannot continue to exist.

It is doubtless a fact that active pressure exists in some of these formations before they are disturbed; but during the work of excavating, the equilibrium that had existed in the mass of earth behind the face of the excavation is destroyed by the loss of those components contributed by the earth that has been removed. If the face of the excavation then comes to a condition of repose at a slope inclined but little from the vertical, or requiring little assistance to remain so, the forces that had composed the active pressure have become adjusted to a new condition of equilibrium in which the earth does not tend to push outward and exert a thrust against the tank wall when built.

With such formations, then, the extent to which they can assist the tank is measured by the amount of horizontally applied pressure the earth is able to withstand without compressing enough to permit the tank to expand up to the cracking point. Further, if the tank surrounded by earth incapable of exerting active pressure be other than truly cylindrical when filled with water, the wall will be drawn away from the earth at the ends of the greater diameter, and thereby cracking will be induced at the ends of the lesser diameter.

It thus appears that some formations sufficiently firm to be conveniently excavated are very unsuitable for enclosing a brick tank. The best site for such a tank is doubtless one where the formation consists of either hardpan or stiff clay. The expense of excavating eliminates rock from consideration. While saturated ground is capable of greatly assisting the masonry, the excavation is expensive, and the gelatinous condition of the soil makes probable the transmission of distant shocks.

It commonly occurs that brick tanks are cracked by the driving of piles near by; but the writer has direct knowledge of two having been damaged by the use of explosives in removing an obstruction from a river two blocks away.

It is now material to discover, in exact terms, just what assistance the tank wall shown in fig. 4 (*ante*, p. 402) requires of the earth. The ring tension S at a depth of 30 feet has been computed as 14,450 lbs. If the unit stress in the brickwork be limited to 70 lbs., there will be a factor of safety against cracking (the only form of failure that concerns us) of about 3. The proportion of the internal pressure thus resisted by the masonry P^b may be deduced from the following equation:

$$P_b = \frac{70}{\frac{S}{12T}} = \frac{840T}{S} = \frac{5,880}{14,450} = 40{\cdot}7 \text{ per cent.}$$

The increment of increase in the radius of the tank d_1, due to the circumferential stretching of the wall under a unit stress of 70 lbs., is $d_1 = \frac{12\,(D+T)\,\frac{U}{E}}{2} = \frac{12 \times 192 \times 80}{2E} = \frac{80,640}{E}$.

As has been stated, investigation has failed to determine any satisfactory value for E—the modulus of elasticity of brickwork. However, it is logical to assume this modulus as not varying materially from that of the cement mortar, which modulus has been found to lie between the limits of 500,000 lbs. and 1,500,000 lbs. If we assume the average of these values, and solve the equation $d_1 = \frac{80,640}{E}$ there results 0·0806 inch as the amount the brick wall at a depth of 30 feet advances outward in performing its share of the work.

The outward pressure of the water on one square foot of wall at a depth of 30 feet is $30 \times 62{\cdot}5 = 1875$ lbs., of which 100 — 40·7, or 59·3 per cent., must be resisted by the earth. Hence, we may conclude that, in the absence of either active or passive pressures, the tank will be secure against cracking if the earth-backing be capable of developing a resistance of $0{\cdot}593 \times 1875 = 1110$ lbs. per square foot while compressing not more than 5-64th inch. It is difficult to believe that such a condition has been frequently realized. The practice of reinforcing brick tanks by steel bands would indicate that the builders of tanks have not found the earth backing a very dependable assistance.

Of the six masonry tanks approximating 185 feet in diameter observed by the writer, three are reinforced with steel bands. These bands are all $\frac{5}{8}$ inch thick and about 5 feet wide. In apparent compliance with Arson's theory, these bands were placed just below the second offset from the top of the wall. It is a fact of much significance that, though these tanks rest on bed rock and are surrounded by very firm ground, one of them has cracked below the band.

In designing these tanks, it was doubtless assumed that there would be imposed upon the band a tension approaching the maximum safe stress on the metal. As a matter of fact, such a result could only be attained by cracking the masonry. Assuming the unit tension in the brickwork to be limited to 70 lbs., and the modulus of elasticity to be 1,000,000 lbs., the maximum stress possible in the steel may be deduced from the relation of the modulus of elasticity of brickwork to that of steel. The accepted value of E for steel is 29,000,000 lbs. Applying these values, the unit tension developed in the steel under the conditions assumed would be $\frac{29,000,000}{1,000,000} \times 70 = 2030$ lbs. With the brick stressed-up to the breaking point, the unit tension in the steel would be only about 6000 lbs.

With average unit stresses of 2030 lbs. in the steel and 70 lbs. in the brickwork, the band will co-operate with a ring of masonry 7 ft. 1 in. in height in resisting the hydrostatic pressure included between the planes coinciding with the top and bottom of the masonry ring, as shown by fig. 8; the highly-stressed lower courses of brickwork receiving no assistance whatever from the band. The total tension in the ring and band developed by the internal pressure is 400,000 lbs. With a joint efficiency of 80 per cent., the band would be capable of resisting the entire tension while under a unit stress of only 13,500 lbs.

Though we assume any other possible stress for the masonry, and any other probable elastic relation between it and the steel,

or any other vertical position for the band, similar results will follow, and we shall find that whatever tensile resistance can be developed by the combination of brick and steel can be secured from the steel alone. Hence, if the brick tank here discussed were reinforced with steel bands properly proportioned to keep the unit stress in the masonry below 100 lbs., it would require as much metal as a steel tank.

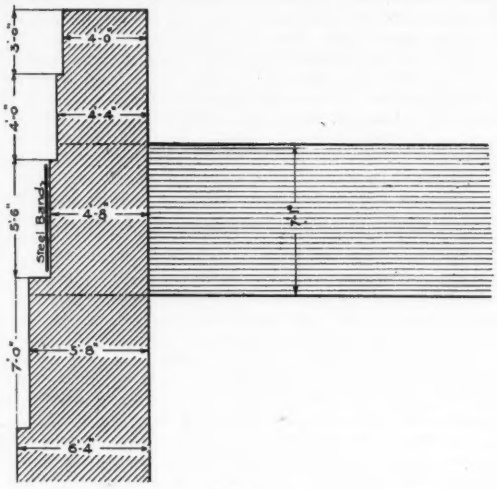


Fig. 8.

An established feature of modern engineering is the preference, in planning large structures, for those designs and types in which the expectation of security is based upon faith rather than hope. This may also be stated by saying that engineers avoid those designs in which the stress conditions resulting from the system of loading governing the design are either materially uncertain or not susceptible of determination. The most frequent occasion in gas engineering for applying this criterion is in the designing of holders. If the criterion should be applied even in moderation to tank design, but few brick tanks would ever be built.

The writer has observed lay formations of such stability that they could not be excavated by ordinary methods. These deposits were being quarried for use in the ceramic arts. If such a formation should be found upon a site selected for a gasholder, a strong and inexpensive tank could be constructed by merely lining a circular excavation with a thin brick wall constructed with suitable piers for supporting the guide-framing. The cost of the tank would be largely defrayed by the sale of the clay. Such were the circumstances at Manchester; the clay having been made into a high-class brick at the site. In view of the facts, it is strange that the designers exerted themselves to devise a fictitious resistance for a wall palpably incapable of taking even a fifth part of the internal pressure.

The writer has knowledge of an engineering work where the test borings disclosed a subsoil of hardpan possessing such stability that the contractors bidding on the work were advised to estimate the excavation as being in rock. If such a formation as this should be encountered in locating a holder, a tank economical and strong could be built as before, by merely lining the excavation and providing piers for supporting the guide-framing.

For a tank to be so constructed, it would be necessary that the formation of clay or hardpan should extend considerably beyond the tank area; and evidently any disturbance of the adjacent ground would be a serious matter.

The idea seems to be prevalent that the first cost of brick tanks is in general less than that of steel tanks. It is the writer's belief that a brick tank can cost less than a steel tank only when the work begins with favourable conditions, and is accompanied by them as it proceeds. If the conditions require much sheet-piling and pumping, the cost of a steel tank is certain to be exceeded.

While plain concrete tanks were built more than thirty years ago, reinforced concrete tanks have only appeared in the last decade. These reinforced tanks represent three different types of construction—

1. Tanks with plain annular walls: the concrete being assumed to participate in the work of resistance.
2. Tanks with relatively thin walls, provided with outstanding piers for supporting the guide-framing; the steel reinforcement being assumed to take all the tension.
3. Tanks similar to No. 2, but with relatively thinner walls belted with hoops of reinforced concrete; the steel being assumed to take all of the tension, as before.

There are two other types for which the writer has seen designs, but has no information as to their having been built. One of these types is designed with a wall similar to the familiar retaining wall with counterforts. In the other type, the wall consisted of a ring of arches in a vertical plane, sprung between buttresses that were assumed to receive the outward thrust of the arches and hold them in together against the hydrostatic pressure. In neither case was the wall as designed capable of offering much resistance to tension. Hence, unless a tank built from either design rested upon solid rock or was surrounded by a very firm earth formation, it would certainly crack; for absence of circumferential tension would require the counterforts or buttresses to be absolutely unyielding. If they were not thus rigid, their outward movement would be necessarily accompanied by an increase in circumference; and any such increase means tension. If the wall were surrounded by a formation of firm clay or hardpan, the backing would probably be capable of withstanding the entire outward pressure with less compression than would cause the concrete to crack; but the buttresses or counterforts would be useless, and would contribute nothing whatever to the strength of the tank.

At the time the two 300-feet tanks at Astoria were being designed, Mr. Bradley and Mr. Bruce made an exhaustive investigation into the question of concrete tank construction. The writer was employed upon the work as draughtsman and computer. There being practically no precedent to consider, various types of construction were devised, then analyzed and compared. The conclusion was finally reached that the concrete tank most easily and quickly constructed, at the least cost, and in service the most reliable, was the type already described as No. 1. The experience accrued during the construction of the two tanks at Astoria and the tank 189 feet in diameter built for the Central Union Gas Company fully justifies the conclusion that this type No. 1 is preferable to any other design of concrete tank.

The disadvantages common to both types Nos. 2 and 3 are too obvious to require much discussion. If all the tension is to be taken by the reinforcement, then evidently the quantity of steel in the hoops and vertical bars will exceed that sufficient for the shell of an ordinary steel tank. To whatever extent reinforcement in place may cost less than the equivalent plate work, the economy is more than offset by the cost of the concrete. The writer believes it has been fully demonstrated that, while the cost of any type of concrete tank must exceed the cost of an equivalent steel tank, the cost of types Nos. 2 and 3 is prohibitive.

The structural objections to types Nos. 2 and 3 are, first, the care required to properly locate the reinforcement and secure it against displacement; and, second, the great difficulty of reducing the concrete to a compact mass when its flow is obstructed by the mesh of the reinforcement. Yet whatever strength such a tank can possess is measured directly by the extent to which both these requirements have been accomplished. The design of a tank of type No. 3, which was built in 1908, called for a circumferential reinforcement of $\frac{3}{4}$ inch bars spaced $2\frac{1}{2}$ inches centre to centre and $\frac{1}{2}$ inch vertical bars spaced $11\frac{1}{2}$ inches apart. It is alleged that the work was executed in accordance with the plans. Hence, unless the builders resorted to a process resembling dentistry, we are expected to believe that the concrete, when tamped, flowed through a space $1\frac{3}{4}$ inches wide by $11\frac{1}{2}$ inches long and became thoroughly compacted around the bars. Fortunately, this tank is surrounded by saturated ground.

Within the last few years the Board of Public Works of New South Wales built four water-tanks differing in design from type No. 2 only in the omission of piers. In 1909, one of these reservoirs totally collapsed. Though designed for a head of 40 feet, it contained at the moment of failure only 32 feet of water. The engineers who investigated the collapse reported the two principal causes of failure as being: First, the concrete had not been thoroughly bedded around the bars, under which condition the tensile resistance of the steel could not be developed; and second, the filling of the tank began "only 98 days after its completion."

The engineers did not state what in their opinion should have been the age of the tank before filling; but it is possibly indicated by a series of tests they had made, in which specimens 98 days of age were compared with others six months old. If a concrete tank requires any such period of seasoning, then the significance of the necessity is best realized by considering the fact that large holders with steel tanks can be erected in six months.

The analysis of stresses for a concrete tank of type No. 1 is substantially the same as that which has been applied to brick tanks. In this case also the secondary stress resulting from ellipticity may be a serious matter. With great care and much supervision during construction, any considerable ellipticity may doubtless be avoided. However, the writer believes that there is sufficient probability of a tank being other than truly circular to justify an assumption that d (the increment of ellipticity) has a value of $\frac{1}{2}$ inch per 100 feet of tank diameter.

In the discussion of brick tanks, there was considered the restraint exerted by the foundation upon the lower part of the wall. In a concrete tank of type No. 1, this restraint may be safely assumed to be effective for a distance above the tank bottom equal to 1·75 times the thickness of the wall. Hence, the maximum wall thickness and the depth to the plane of maximum tension are reciprocally dependent. A preliminary computation of the wall thickness may be made, assuming the plane of maximum tension to be 0·8 of the depth below the top of the tank.

Evidently the consequence of this restraint upon the wall is a shearing stress in the plane of attachment to the foundation. The responsibility of resisting this stress should be imposed upon vertical bars imbedded in the foundation and carried up 5 feet into the wall.

The proper unit stresses for concrete gasholder tanks is still an open question. There has as yet been neither sufficient experience nor investigation to justify any very positive conclusions. In a tank of type No. 1, the stress in the steel is dependent upon

the elastic relation of the steel to the concrete. The modulus of elasticity of concrete is an indeterminate quantity. Numberless tests have been made, giving values of from 1,500,000 lbs. to 5,000,000 lbs. The Building Department of New York City assumes the ratio of the modulus of elasticity of concrete to that of steel as being 12; but 15 is the ratio most frequently assumed by engineers when not restricted by ordinances.

The unit stress that may be safely assumed for the concrete is somewhat dependent upon the character of the surrounding earth. For instance, if the tank be located in saturated ground, we may, with considerable accuracy, compute the minimum value of the active pressure that will act inward against the wall. Hence, if the unit tension in the concrete were assumed at 90 lbs., we might expect, with reasonable certainty, that this stress would never be exceeded. If, however, the tank be surrounded by damp sand, it would be hazardous to assume such a stress as 90 lbs., unless the sand be regarded as incapable of either active or passive pressure.

With the earth pressure assumed in designing the Astoria tanks, the maximum tension in the concrete would be 83 lbs.; but from the character of the formation, as disclosed by the excavation, the writer would conclude that it does not exceed 25 lbs.

In the case of tanks of type No. 1 under 175 feet in diameter, the wall thickness will generally be determined by the width at the top necessary to accommodate the base of the guide-framing standards. This thickness, if continued down to the bottom, may sometimes be in excess of that necessary to resist the maximum tension. Hence, it may be suggested as an economy that the wall thickness be reduced and piers added to the outside of the wall for supporting the guide-framing. It can be shown, however, that such a modification may result in increasing the cost of the work. Tanks of type No. 1 are usually constructed by moulding the concrete between two concentric rings, each consisting of segmental forms about 6 feet high. As the work proceeds, these forms are slid upward in vertical guides. It is apparent that outstanding piers will interfere seriously with the continuity and facility of this process, and offset the economy in concrete. Also, from a frequent experience with buttressed retaining walls, we may conclude that the corners formed between the wall and piers favour the development of cracks. The design of type No. 1 is based upon a theory, supported by experience, that it is cheaper to put in more concrete and avoid complicated form-work and tangles of reinforcement.

In proportioning the reinforcement for type No. 1, it is not advisable to exceed 2½ per cent. in any unit-height of the vertical section. If this amount be materially exceeded, the bars will be spaced too closely to permit the best results in placing the concrete; and the additional steel, not being economically employed, will increase the cost very perceptibly.

The concrete in the upper half of the wall will rarely require the assistance of reinforcement in resisting the ring-tension; but one-half of one per cent. of steel in that part of the wall will do much to prevent shrinkage or temperature cracks.

Except in the unusual case of a tank having earth formations radically different in behaviour acting against opposite arcs of its circumference, any computation of the tank's resistance to externally applied pressure is unnecessary. Though we should assume an external fluid pressure from a saturated earth weighing 110 lbs. per cubic foot, the maximum unit compression in the concrete would not exceed 600 lbs.

Only very small tanks of types Nos. 2 and 3 have as yet been built. These tanks have most of their depth above the surface of the ground. As has been stated, these types of construction are expensive. Hence, for economy, it has been the practice to employ the steel at stresses as high as 25,000 lbs. When the stress in the steel reaches 5000 lbs., every vestige of the tensile resistance of the concrete has been destroyed. It is not this fact in itself that concerns us, however, but the attendant condition of the concrete. It has been established by experiment that when concrete is thus strained, there is developed a countless number of cracks which, though invisible, are not less real. In this condition the concrete is not impervious to water; and it has been found that a mere seepage through the wall will eventually become a flow. Furthermore, the alternate freezing and thawing of the water in the cracks results in a gradual splitting of the concrete.

In 1907, the Board of Water Supply of New York City made extensive tests with a reinforced concrete cylinder 11 feet in diameter and 210 feet long. The walls of the cylinder were 8 inches thick, and contained 5 per cent. of reinforcement. The high grade of the concrete was shown by the average ultimate tensile resistance of 330 lbs. developed by specimens seven months old—that being the age of the cylinder when first subjected to pressure. Under a head of 28 feet, the leakage from the cylinder was over 900 gallons per hour. After the interior surface of the concrete had been grouted twice and coated with cement mortar, the leakage was reduced to about 45 gallons per hour under a head of 34 feet. Under this last condition, the steel was under a unit tension of only 1100 lbs. The writer does not know what conclusions were formed from these tests; but he assumes them to be reflected in the practice of the Board of Water Supply, of limiting the unit stress in the reinforcement of water-retaining structures to 8000 lbs.

The existing gasholder tanks and reservoirs conforming substantially to types Nos. 2 and 3 in design have maximum wall thicknesses of 18 inches for No. 2 and 10 inches for No. 3. A considerable increase in this wall thickness would doubtless prevent seepage; but this would lead us in the direction of type No. 1.

Tanks of these types cannot be made tight by waterproofing, for the reason that such coatings, to be effective, must be applied to the inner surface while the wall is under tension. If applied to the outside, it will be useless. Such tanks have been made tight by charging the water in them with cement; but there is no certainty of this process being successful unless all the water in the tank be converted into grout.

In some very important particulars, concrete tanks of any type are less desirable than those of brick. For, while brickwork has been discussed as an uncertain material for resisting tension, concrete is even less dependable when thus employed. The structural principles of concrete and brick-masonry are essentially the same; but the latter represents the systematic assemblage of the elements. This process permits complete inspection as the work proceeds. Brick-masonry does not require the exercise of any peculiar skill, nor that momentary vigilance so necessary in concrete work. Hence good results are more easily secured. Concrete work may turn out unintentionally bad; but it will never be accidentally good.

Brickwork is not liable to the serious cracks that develop so frequently in concrete as a result of the inherent shrinkage stresses. Furthermore, it is a simple matter to repair the wall of a brick tank and obtain the original strength. With concrete, repairing is difficult, and the results doubtful.

In the event of a destructive storm during the building of a masonry tank, any damage sustained by brickwork would be palpable, while impaired concrete might escape observation.

When a more extended use of concrete began (about ten years ago), it was believed that structures built of sand, cement, and broken stone were practically immortal. They were said to become a part of geology. Doubtless the experience accrued in the last ten years has convinced engineers that concrete structures are not more enduring than the other works of man.

In no other field of human industry have science and skill been so extensively and successfully applied as in the production of structural steel. Manufactured from the most important of the metallic elements, the original granular formation is really transformed into an elastic fibrous structure. Structural steel is manufactured in several grades, each differing from the other in physical properties. The desired properties of tenacity and ductility are developed by mechanical processes, and by varying the proportion of certain chemical constituents. The custom of specifying these chemical properties in "hundredths per cent.," indicates the perfection that the art has reached. The certainty and uniformity with which any specified grade or quality of steel may be produced is in marked contrast to the random results from the manufacture of other structural materials.

An ideal stress condition may be described as the condition which is developed in a material of definite and uniform elastic properties by a completely known force. Such ideal conditions are never more nearly attained in practice than when steel is employed to resist fluid pressure.

The usual specification for steel plates for gasholder tanks permits a variation of 10,000 lbs. in the ultimate tensile strength, and requires the elastic limit to be not less than one-half the ultimate. The ultimate strength of tank plates is generally assumed at 60,000 lbs.; and records available to the writer of tests made upon thousands of tons of such material show rare instances where the variation from this figure was 5 per cent. Hence, it may be said that while steel tanks are designed upon an average resistance which varies 10 per cent., masonry tanks are proportioned upon the basis of the poorest material that human frailty may permit to enter the structure. Someone has defined a factor of safety as the "factor of ignorance." In the case of masonry tanks, it would be very properly defined as the "factor of our helplessness;" for we are helpless to either influence or control the tensile resistance of masonry within 100 per cent.

Fig. 9.

The shell of a steel tank, like the wall of a masonry tank, receives material assistance from the bottom, though this fact is not usually considered in designing. Fig. 9 is an exaggerated representation of the elastic deformation of a steel tank. The thickness of the plates at the top of the shell is governed by practical considerations, and is always much more than the stress conditions would require. This excess of metal, assisted by the circular girder, reduces the diametral expansion at the top of the tank to a very small amount. At the bottom of the shell, the diametral expansion is reduced to an almost imperceptible increment by the restraint of the bottom. The amount of this restraint is best realized by conceiving a large tank to be cut into two parts by a vertical diametral plate. Then if the coefficient of the static friction between the bottom and the foundation equals 0·3, the friction would exceed the whole bursting pressure tending to spread the two halves of the tank apart. Or, ignoring the friction and assuming a joint efficiency of 50 per cent. for the bottom seams, the bottom plates would be capable of resisting the entire hydrostatic pressure acting on the lowest 10 feet of the tank shell. The flexibility of the plates will, however, prevent the restraint from being materially effective above the first rim.

The assistance contributed by the bottom of the tank to the lowest rim of side plates is much more effective when the curb angle is placed on the outside of the tank. If, with such a condition, the thickness of the lowest rim be proportioned to a stress computed from the condition of an unrestrained ring under hydrostatic pressure, an analysis of the elastic behaviour of the rim in connection with the curb angle and tank bottom will show that the actual unit stress at the bottom of the rim does not exceed 10 per cent. of that assumed in designing. If the rim approximates 4 feet in height, the unit stress at its upper edge will not exceed 90 per cent. of that assumed in the design. From this it will be seen that, having determined the unit stress permissible in the plates, this stress will be more nearly approached if the thickness of each rim is proportioned to the tension at the centre of the rim. The frequent practice of proportioning the plate thickness to the tension at the bottom of the rim is inaccurate, and results in an unnecessary amount of metal. It is certainly neither rational nor intelligent designing to accept one unit stress as permissible, and then assume fictitious conditions that produce some other stress.

Though gasholder tanks of steel have been in use for more than twenty years, there is still a lingering distrust of their security. Those who entertain this distrust seek to justify it not by the failures but by the lack of them. The idea seems to be that a failure is more or less equivalent to a test to destruction; and hence, if more steel gasholder tanks had collapsed, their behaviour under pressure would be better understood. There is doubtless some logic in this argument; but from the fact that of all the many large steel gasholder tanks that have been constructed during the last twenty odd years there is a record of but one failure, we may safely conclude that a more exact knowledge of the true stresses in the tank shell would result in less metal and rivets than are employed in the practice at present.

In connection with the recent design and construction of two large steel gasholder tanks, tests of prepared riveted specimen joints were made by the builder. The tests indicate:

1. That the strength of a double butt-riveted joint is not less than the total strength of the elements of which it is composed, taken separately.
2. That the ultimate resistance of a tank plate is less than the stress which would be necessary to break down the friction in the joint.
3. That the frictional grip in such joint is so great that, within the limits of working stresses, there is neither shear in the rivets nor bearing stress against the shank.

Fig. 10 is a partial cross-section of the spherical type of tank of which several have recently been built in Europe. With this design, the thickness of the plating is independent of the diameter. The profile of the tank on a radial line is an equilibrium curve known as the hydrostatic chord. The tension at any point in the walls of any vessel having a curved perimeter under fluid pressure in equilibrium is equal to the product of the unit pressure and the radius of curvature. Hence, as the internal pressure is met by the tensional resistance in a meridional plane without developing any serious circumferential tension, it is evident that this design permits the plating to be very thin. To make the nearest approach to ideal stress conditions requires that the shell of this tank shall be uniform, elastic, and unrestrained.

The advocates of this new type of tank are asserting its alleged advantages with an immoderation that may remind us of the enthusiasm with which the suspension bunker was first introduced. The suspension bunker has been in the field now for some twenty years. It has its merits, and is extensively used; but it has absolutely failed to eliminate those standard types of bin construction that were in use before it appeared. If a spherical tank is to eliminate the usual cylindrical form, the design must be

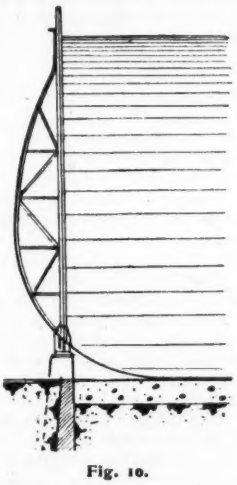


Fig. 10.

demonstrated as possessing more considerable advantages than have yet been shown.

In the "JOURNAL OF GAS LIGHTING" of July 5, 1910, there appeared a discussion of steel gasholder tanks by M. Edouard Bonnet. The paper is an argument for the new type of tank, and consists in comparing the alleged disadvantages of the cylindrical construction with the supposed advantages of the spherical tank. Nothing is stated by the author about the disadvantages of the spherical tank. M. Bonnet begins his condemnation of cylindrical tanks by acknowledging the bottom plates as being necessary to retain the water. In the next sentence, he states that the bottom contains an "amount of metal . . . . which has no really useful place in the construction." If this statement be true, it follows that the shell of the tank is also unnecessary, as likewise its only purpose is to retain the water.

The thickness and behaviour of the tank shell is next discussed by M. Bonnet. He takes a serious view of the difficulty and labour involved in assembling the heavy plates required for the cylindrical tank. The fact that the entire first rim of the 10 million cubic feet holder at Newtown was assembled and riveted in eleven working days without extraordinary effort, would suggest that M. Bonnet is not without prejudice. He then states that, "while the interior pressure increases the diameter of the tank, the bottom of the lower ring of plates, strengthened by the angle iron and held by the bottom plates, cannot take part in the general tension of the circumference, and causes partial strains which are dangerous and lead to bursts." Can M. Bonnet explain why the condition of the lower ring of plates is dangerous when it is "strengthened by the angle iron and held by the bottom plates"? Also, why are "partial strains" more serious than the entire strain?

His next statement is that the circular girder at the top of the tank does nothing. "Its only effect is to insure the circular form of the tank, and it adds nothing to its strength." From this we may assume that a tank is not strengthened by insuring its circular form. It would also greatly enlarge our knowledge if the "certain parts" of a cylindrical tank in which the metal "exerts itself badly" were definitely stated.

A fair comparison of the two types of tank will show that the reduction in plate thickness which the spherical tank permits is its sole advantage. The spherical tank, as constructed, makes no closer approach to the ideal stress conditions upon which the design is based than does the cylindrical tank. A mechanical analysis of the hydrostatic chord assumes the element to be unrestrained at any point between the termini. The spherical tank is not, and cannot be, so constructed. The tank described by M. Bonnet has a number of radial vertical girders attached to the outer shell; there being apparently one girder under each guide-framing standard and two in the space between. The bases of these girders are supported by pedestals outside of the shell resting upon the annular foundation. Each vertical element of the tank coinciding with one of these girders is subjected to considerable restraint; while an element midway between is free except to the extent to which the rigidity of the plating may transmit the restraint of the girders around the circumference. Will some advocate of the spherical tank enlighten us as to the extent to which the ideal stress conditions are disturbed by this restraint, or as to the nature and amount of the stress thus induced? Further, M. Bonnet, referring to the stress induced in a cylindrical tank by the guide-framing, states "such a tank . . . . has thus added to it considerable strains, varying in position and intensity, which it is almost impossible to ascertain." In view of this statement, it is somewhat remarkable that he omits any discussion of the corresponding stresses in a spherical tank.

M. Bonnet discusses tank foundations in utter disregard of the fact that the shell of a cylindrical tank represents a circular girder of great depth and stiffness. The writer has seen a cylindrical tank of large size, the foundation of which has been undermined by adjacent excavation without serious results. A spherical tank is a relatively flabby construction, and is absolutely dependent for its security upon an unyielding foundation. If one arc of the annular foundation were to subside, is the structure of the spherical tank adapted to bridging across the depression? An unequal settlement of cylindrical tanks has occurred with sufficient frequency to demonstrate the inherent strength of its form as a circular girder. The author also states, referring to spherical tanks, "even the bottom only supports the weight of water." What else does he assume the bottom of a cylindrical tank to be carrying? He then says that "calculation has shown that an important depression in this part of the foundations would require only a slight increase in the work done by the plates." The author might observe, in this connection, that calculation has shown that an important depression in this part of the foundation under a cylindrical tank would reduce the work done by the plates in the shell; and actual experience has demonstrated that no harm results. An unmistakable advantage of the cylindrical tank is its security when supported upon an annular foundation. The Consolidated Gas Company of New York have a holder the steel tank of which is 193 ft. 2 in. in diameter and 41 ft. 9 in. deep; the tank being supported by an annular pile foundation. The site was originally under water, and was filled in upon black river mud of a considerable depth. The foundation has now carried the load for twenty-two years without settlement.

All innovations should receive a fair hearing and full consideration; but, on the other hand, the claims of merit should be candidly and honestly presented. The writer does not believe that much can be accomplished for an alleged improvement by subjecting existing practice to unfair and truthless criticism.

Though steel tanks have been built in large numbers, there seems to have been little investigation into the behaviour of the

inner surface of the plating where exposed to the action of the water in the tank. Hence the question has been frequently raised as to what might be the effect of the water upon the inner surface of the shell. During the present year, the writer had opportunity to examine a large steel tank which was built at a time when the manufacture of open-hearth steel plates was in its infancy. The material in this tank has been shown to be of very inferior quality; but notwithstanding this fact, after nearly twenty years exposure to the action of the water, the interior surface of the shell could be described as being in perfect condition.

The Consolidated Gas Company have usually placed their large steel tanks with some part of their depth below the level of the surrounding ground. It has been their practice to protect the shell below the ground level with a thin concrete wall. A recent examination of the tanks so located showed that the concrete remained in absolute contact with the surface of the plates, and that no corrosion had occurred.

Among the distinct advantages of steel tanks, when compared with those of masonry, are:

1. Less cost.
2. Shorter period required for construction.
3. The ease with which the quality of the work may be controlled during construction.
4. The high state of development in fabrication and erection.
5. Greater reliability under stress.
6. Accessibility for inspection.
7. Tank may be placed at any elevation with relation to the ground line that may be desired.
8. No liability to damage by storm during construction.
9. No internal stresses from shrinkage or temperature that are serious.
10. Possibility of rectifying an unequal settlement.
11. No liability to cracking from undetermined causes.
12. The ease of making repairs and obtaining the original strength.

The writer may be charged with entertaining a strong prejudice against masonry tanks. He will admit that he is opposed to any type of tank, 25 to 40 per cent. of the cost of which may go into digging a hole in the ground, instead of putting quality into the structure.

SCOTTISH JUNIOR GAS ASSOCIATION.

EASTERN DISTRICT.

A Quarterly Meeting of the Eastern District Division of this Association was held on Saturday in the Masonic Hall, Kirkcaldy—Mr. W. Dunlop (Kirkcaldy), the President, in the chair.

The President welcomed the members, of whom more than thirty were present, and introduced Mr. W. Ewing, of Lochgelly, who, he said, though making his first appearance among them, was by no means unknown. As a matter of fact, his personal abilities were recognized far and near.

ADDRESS BY MR. W. EWING.

Mr. William Ewing (Lochgelly) gave what he described as a homely address. After a few preliminary remarks, he proceeded: We meet at times with men whose names are destined to live in the history of the gas profession after death. Their excellent work remains behind them in a material form, in the shape of apparatus, discoveries, Acts of Parliament, &c., to which they have devoted their whole lives and energies for the benefit of the profession. To live in the hearts and thoughts of those left behind is the finest memorial a public benefactor can have. It was my privilege, over three decades ago, to serve the late Mr. William Young during his experiments with tar and other hydrocarbons before and after the erection of the Young and Aitken analyzer. As a young lad, what struck me most about this scientist and experimentalist was the calm, kindly, and magnetic demeanour and wonderful patience and enthusiasm he showed over experiments, which left a lasting impression upon the mind. He was endowed with an active mind, and privately spent large sums on experiments the results of which the gas profession find invaluable to-day.

The late Sir George Livesey will ever be remembered as the greatest personality the gas profession has seen. We are indebted to him for much that made for progress during his wonderful lifetime, and for the successful results that followed in the train of many a hard-fought battle. He was the Napoleon on whom we relied in the hour of need; and he never failed us. When you met him, you were struck by his courtesy and his knowledge of what you were doing. Nothing was too trivial to escape his notice so long as it contained a gas problem.

There is another gentleman to whom I feel greatly indebted (whose experiments with retort-settings I was privileged to see and watch over two decades ago, and learned what to avoid)—Mr. George Anderson, a native of this county. Though now feeble in health, he is happily still with us. His inventions of last century are in use in nearly every gas-works to-day. His career has been a great and useful one to the profession which he adorned before retiring. It is men such as these that give to the young men the necessary impetus to be up and doing, and leave behind them, when departing, "footprints on the sands of time."

When one assumes the management of a gas-works, he either finds the plant requiring much attention, or in good order. I am pleased to say that the Lochgelly Gas-Works, where I succeeded one of your members, was in the latter condition. What first appealed to me was the tidy and fresh appearance of the works and plant, and, secondly, the extraordinary amount of work accomplished in about four years by my predecessor Mr. J. D. Keillor. The first condition reflects the nature of the man in charge, and the second the ability and energy with which he is endowed. When I tell you the make of gas has quadrupled in five years, five miles of main pipe and twenty miles of new services laid, not to mention fully 1000 houses gas-fitted by our own men, including about 1600 stoves and nearly 2000 new consumers, you can form an idea of the amount of energy expended. The whole works were remodelled and enlarged to meet the demand for gas, and the first high-pressure system in Scotland introduced; also a sulphate of ammonia plant added.

This is certainly a record for any young man to be proud of. Mr. Keillor was most fortunate in having a Board of Directors who gave him a free hand. In many places, where a manager is "cribbed, cabined, and confined" by restrictions, &c., opportunities are lost for doing the best work; but this never happens with an enterprising gas company. These are places where one may have to endeavour to put a quart into a pint measure, and make the best of existing circumstances. Ones duty is to make the loss as small as possible, and hope for better and larger plant. An old or small plant is a great source of worry to the gas manager; but remember the sweetest music is played on old fiddles. The best results I ever had were obtained by making the best of old condemned plant, and that nearly two decades ago. The most of these results, if not all, stand as a record, at least so far as Scotland is concerned, even to-day. Gas of 25-candle power was sold at 2s. 1d. per 1000 cubic feet, or 1d. per candle. When the price of coal was about 15s. per ton, no change was made in the price of gas. The sale of coke reached 10 cwt. per ton from cannel coal and shale, which was solely used. The cost of carbonizing ranged from 1s. 6d. to 1s. 9d. per ton. The wages bill was the smallest by a long way of any other gas-works of the same size, and yet the rate of wages was the highest paid in Scotland. Many people asked me how it was done; and my reply was "elbow grease, and every man a full and efficient unit of work." I had a staff and workmen who knew their duty, and did it.

If anyone is doing good work, it will show itself by a reduction in the price of gas or an increased dividend. You sometimes meet a man who claims, after a reconstruction, that he is saving 1s. 6d. per ton in carbonizing wages; and yet his gas is no cheaper. His former costs are compared with his own previous bad working, which might be 3s. 6d. per ton; and the 1s. 6d. of supposed saving is sometimes absorbed in extra interest, sinking fund, &c., on some elaborate and unnecessary plant. Often when the best is made of a plant, and some elbow grease used, the 1s. 6d. is a true gain, *plus* the interest and sinking fund and increased make of gas per ton of coal. Never increase your capital expenditure unless your best working is done at a loss. It has all to be paid out of profits, and saddles you with a further capital for about thirty years.

One thing I should like from one of your members, and that is a good paper dealing with the illuminating power of gas in Scotland, past and present, and its relation to present prices charged per 1000 cubic feet—giving, of course, the present and former prices of coal. It would be most instructive.

At the close of the address,

The President said the members had listened with pleasure to Mr. Ewing's remarks, and he was sure they would agree with him when he said they were indebted to him for the words of advice he had given them. He had put before them many of the difficulties they were likely to meet when they launched out on their own account, and had imbued them with a spirit to overcome the difficulties as they cropped up. Much had been said in the Technical Press and at Association meetings regarding the course of training most suitable for a young man entering the gas profession; but, as Mr. Ewing had pointed out, success did not necessarily follow any particular course. To succeed, there must be the right man in the right place. That a knowledge of the applied sciences and a few years spent in an engineering shop were beneficial to the budding engineer, could not be gainsaid; and in these days of commercialism, the value of a commercial training was becoming more apparent every day. But with all this, much of the course advocated in the address must be pursued. He asked the members to express their indebtedness to Mr. Ewing by according him a hearty vote of thanks.

Mr. Ewing thanked the meeting for the courteous reception they had given him. He was starting life afresh, and like, or rather unlike, the young man, he knew what to do. A young man entering upon life found many snares; and the most successful man was he who did his duty and never faltered—who went on the right course, and went on to success. He would impress upon them that when they came into the managership of gas-works the working unit was the first consideration. His experience was that the man who attained a knowledge of the greatest number of trades—he himself had worked as journeyman at six—found it very easy to specify when he came to the engineering part of a work. Such a man never had extras. He would advise them that their first duty on entering a gas-works was to see nothing for a month or two, and by that time they would have got the details of everything they wanted.

MR. ARTHUR HUTCHINSON ON PURIFIERS.

The PRESIDENT said the next item on their programme was a paper by Mr. Arthur Hutchinson, of Granton, on "Purifiers." He had known Mr. Hutchinson intimately for a number of years, and knew that he was well qualified to deal with the subject he had taken for his paper.

Mr. ARTHUR HUTCHINSON (Granton) read the following paper.

It is a difficult matter to find a subject to put before you which has not been previously given at one or other of the Gas Association meetings; and I hope this paper, which deals with gas-purifiers, with special reference to the luteless type, will be of interest.

WATER-LUTE PURIFIERS.

In the first place, we shall take the old-established and generally recognized water-lute purifier, which, as you know, has ribs cast on the side plates for supporting the old form of wood grid, which was, and still is, generally used in most gas-works throughout the country for gas purification.

These water-lute purifiers are made up of plain cast-iron bottom plates, with flanges bracketed, and faced with special side plates, having the lute made as part of the plate itself or as a separate casting—the former being preferred, both for economy in making and cost of erection. There is also required at each corner of the purifier another special lute-plate, having return corners and internal and external flanges, which are very costly in pattern making, moulding, and machining before they are ready to be put together. Besides, ribs have to be cast on some, and pockets or lugs on others, for receiving the steel T bearers and wood grids. In designing a purifier, care must be taken to see that the depth of the lutes is enough to allow for the greatest pressure likely to come, without blowing water out of them, and allowing gas to escape.

The covers for this kind of purifier are of various forms. In the case of square purifiers, they generally have a slight rise in the centre, with a strong centre-plate and the main bars radiating to each corner, and a truss cup to receive the tie-rods; also a strong forged lifting-eye for connecting to the lifting apparatus. In the case of large covers (say, 30 or 40 feet long), they are usually made curved across the width, and continued along the whole length. This size of cover requires strong curbs and main bars, on account of the large area to be covered and pressure to be resisted. The arrangement of truss cups and tie-rods not being applicable, strong welded lifting-eyes and straps are riveted to the sides and bottom curbs at four different points, which ensures a firm and steady lift.

The holding-down catches used are common to both of these forms of purifier cover. They consist of strong steel bars bolted to the inside of the lute plates with "C. S. K." bolts at reasonable distances, and having a forged eye at the top, and steel lugs riveted to the curb of the covers, with a recess in the centre to allow the forged eye to pass between when the cover is lowered into position previous to the purifier being put into action. A steel cotter, which is secured by a small chain, is then passed through the eye, and projects on either side of the lugs, so that when the pressure comes on the cover cannot possibly move from its position, and is securely held.

This is a general description of the water-lute purifier and its cover, a section of which is shown in fig. 1.

The horizontal wood grid or sieve has been largely replaced by various forms of vertical or hurdle grids, some of which are claimed by the makers to pass three times more gas than flat grids, to be far superior to the others, and to possess the advantage of greatly increasing the quantity of purifying material which it is possible to put into a purifier, and at the same time hold it in suspension in much smaller quantities—thereby enabling the gas to have an easy passage, and yet to eliminate efficiently the the various impurities and to greatly reduce the back-pressure often thrown by purifiers, especially when the material has been in use some considerable time.

All gas engineers and managers, however, do not favour the use of grids for the full depth of their purifiers. For instance, Mr. Herring, at the Granton works, has tried in succession the Jaeger, Cutler, and Spencer forms of wood grids, and has eventually adopted an arrangement which gives every satisfaction. It has short cast-iron grid bearer standards about 12 inches high, instead of these extending to the full height as for the old system of purification, and supporting one tier of steel T bearers. On this tier is carried a layer of wood grids or sieves of the ordinary type used for layers of oxide or lime. On top of these is then placed a much coarser grid, formed of bars 1½ in. by 1¼ in. about 3 inches apart, tied together by two wood battens, about 3 in. by 1¼ in., with two feet to each. This takes a great deal of the weight which otherwise would come on to the bottom grid. After this, the purifier is filled with oxide to a depth of about 3 ft. 6 in. from the bottom. I might here state that the size of the purifiers at Granton is 45 ft. by 30 ft. and 6 ft. 3 in. deep.

We have found this arrangement to give the most satisfactory working results; and the back-pressure is no more than we had under any of the before-mentioned systems. The back-pressure varies between 14-10ths and 20-10ths. By this arrangement we can empty and refill a purifier which will hold about 156 tons of oxide with twelve men in one day; but when filled with grids, it took sixteen men nearly two days. Our system of discharging is by twin elevators, discharging on to a travelling belt conveyor, which delivers into the boot of an elevator; and the material is taken up to the revivifying floor overhead.

LUTELESS PURIFIERS.

Coming to the luteless purifier, which is shown in fig. 2, when Mr. Henry Green, of Preston, introduced his now well-known type, called "Green's purifier," it was received, as new ideas often are, with a certain amount of doubt and prejudice as to its improvement or advantages over the water-lute type. But as time passed, many gas engineers have overcome their conservatism, and have seen the wisdom of the idea; and these purifiers have been adopted all over the country both for large and small installations. The advantages of this type of purifier are

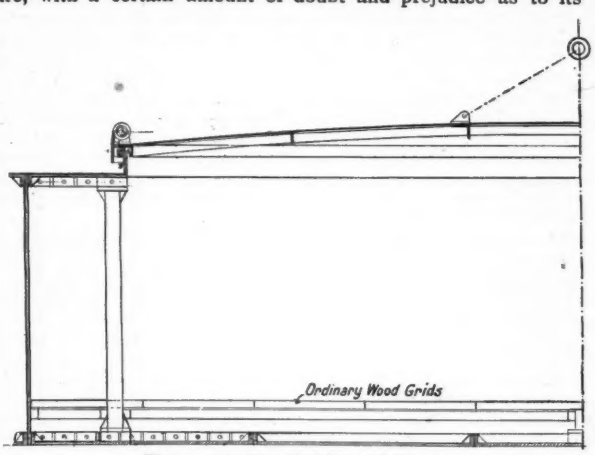


Fig. 2.—Luteless Purifier and Cover.

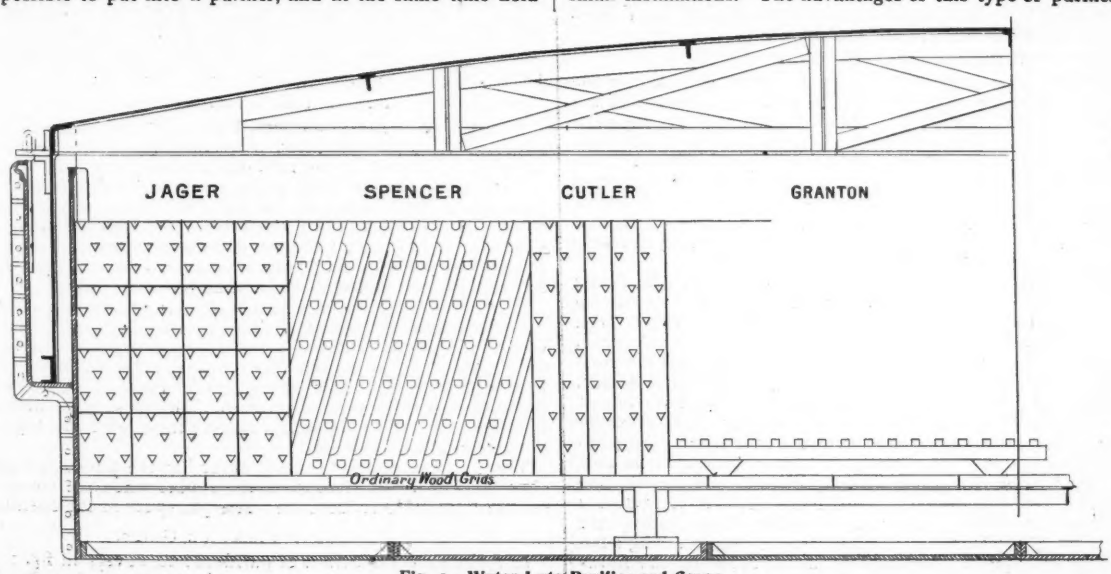


Fig. 1.—Water Lute Purifier and Cover.

that there is no trouble or risk in winter from frozen lutes; while there is a great saving in steam and water connections to the lutes and in the cost of covers. The covers, instead of being of large dimensions, are made much smaller; thereby obviating the necessity of heavy overhead girders and lifting apparatus. In fact, it is in these that the greatest advantage lies, and also in the saving in the height of the cast-iron columns.

These luteless purifiers are constructed of cast-iron bottom plates of the ordinary pattern, about 4 or 5 feet square, with faced and bracketed flanges and side plates, but without the expensive lute plates which are a prominent feature of the water-lute purifier—thereby effecting considerable saving in pattern making, moulding, and general cost to produce. But in this case, as the openings for the covers are not so large, it is necessary to have overhanging cast-iron plates to make up the difference in area. These are of convenient size, and have an upstanding flange which is to receive the covers when in position, either made as part of the plate or separate. A suitable support for these overhanging plates is obtained by a simple arrangement of extending the grid bearer standards immediately underneath them to the full height, and securing them by bolts and nuts to the plates, as shown.

The covers are of the usual construction, designed to resist the internal gas pressure without causing any undue strain on the top sheeting, and with steel angle or other form of curb and main bars. The sheet covering is provided with lugs for four chains, with a centre ring for lifting, or, in the case of small covers, a strong eyebolt only in the centre. The holding-down catches are of different forms—ordinary bolts and nuts, and eyebolts which fit into a slot in the curb of the cover, and when not in use fall down clear. But the best form is an automatic catch which can be so arranged as to release a whole cover, or at least one side of it, by twining a shaft which controls an eccentric movement, and so liberates all the catches at once. There is the "Eclipse" patent fastener, which is the production of Messrs. Clapham Brothers, and also the one known as "Milbourne's patent automatic rapid cover fastener," both of which are excellent ideas, and give every satisfaction in working. The "Eclipse" is fixed to the side of the purifier, the steel shaft running under a cast-iron raised flange; and when the cover is released, the whole of the catches fall clear of the cover towards the cast-iron plates forming the top of the purifier, and leave the cover free to be lifted. The "Milbourne" fastener is just the reverse. The cast-iron brackets holding the discs in position are firmly secured to, and form part of, the purifier cover, so that when the shaft is set in motion the catches are released, and move clear of the raised iron flange; and when the cover is lifted, this and all the fasteners are taken out of the way, so that nothing is left which is likely to impede the movements of those who are in charge.

In making up a specification for this type of purifier, it should be stipulated that each cover is to be provided with a set of approved patent automatic fasteners, with shafting, discs, brackets, and clutches complete, together with the necessary rubber pad, of good pliable quality, properly secured to the under side of the cover by ¼-inch bolts of 12 pitch, in addition to being seccotined, or by other approved means. The curbs of all covers must be absolutely level when riveted up and lowered into position. The joints of the top sheets must be arranged to clear the fastener brackets and all holes for fixing; and the fasteners must be accurately put in to template. Rubber pads are preferable to hemp gasket for making joint between cover and purifier.

When this form of purifier was first brought out, one of the difficulties to be contended with was the satisfactory fixing of the rubber used for making the cover gas-tight. Various shapes and makes of rubber have been tried, and, like everything else, time and experience have solved the problem. The joint is now made by means of rubber flat on one side and round or convex on the other; and it is secured to the steel curb of the cover by T-bolts or other form of fastening, as described later.

General Remarks on Purifiers.

In designing purifiers, it is advisable, when possible, for the length and width to be multiples of 5 feet. The flanges of the top plates should be arranged inside, as this leaves the top platform and gangways clear of such obstructions. The side-plate flanges should be external, to avoid having special sieves. It is usual to have external flanges on the bottom plates when erected on a girder floor, and internal ones when erected on brick or concrete foundations. Flanges should be 2½ inches deep clear of the plate, with round bolt-holes 6 inches pitch, having brackets 6 inches apart, spaced equally between the bolt holes.

Small purifiers, up to 12 feet square, may be 4 ft. 6 in. deep; above this, and up to 700 square feet, 6 feet deep; while those above this area should not be less than 5 ft. 6 in. or 6 feet deep. Under modern conditions, only one tier of wood grids is used, supported on short standards about 12 inches high, and the purifier filled with hurdle or other grids as the engineer may decide. But perhaps it would be as well to prepare for (say) four tiers of grids, though only intended for oxide purification, as local conditions may so vary as to necessitate the use of lime or other purifying agent at some future time. Wood grids should be of a length equal to the side plates of the purifier, and not more than 2 feet wide. It is not wise to exceed these sizes, for convenience in handling when filling or emptying a purifier. The bearing-bars should be of T section, of convenient lengths for handling; the span being arranged proportionately to the depth by the introduction of intermediate standards.

Where there are no chemical restrictions enforced, good purification may be obtained by a set of four purifiers; but six make a more satisfactory arrangement. The use of a pair of catch purifiers is in some degree optional. There is, however, not only safety but considerable economy in their use, as the purifying material in the set of four can be more thoroughly worked up and exhausted.

With the luteless form of purifier, there is no need for heavy lifting apparatus. Therefore, pulley-blocks with travelling carriages running on the lower flange of rolled joist-girders, which can easily be supported from the tie-rods or beam of the roof, may be employed. When the purifiers are out in the open, and this is not possible, a light double-jib travelling crane, running on narrow-gauge rails, should be fixed on the top plates forming the centre gangway of the purifiers.

Milbourne's "Rapid" Fastener.

Milbourne's rapid fastener is automatic in its action, and it enables a complete cover to be unfastened on all four sides by one man in less time than he would take to unscrew one on an ordinary cover. As a 10 feet square cover would have twenty catches, the saving in time and labour is most pronounced. The fastener consists of a square steel rod running along each edge of the cover, and connected at the corners by mitre gearing. These rods are mounted on very simple bearings, and by means of eccentric discs actuate the fastener clutches, which are spaced about 3 feet centres. The opening or closing of the cover is effected on all four sides simultaneously by one action of a hand-lever moving through an angle of about 180°.

In order to fasten down a cover, the first portion of the stroke of the lever brings the holding-down clutches into a position immediately underneath the cast-iron flange or fender plate of the opening; and the remainder of the lever stroke imparts an upward vertical motion to the fastener clutch, which firmly grips the curbs of the purifier and cover together—thus compressing the india-rubber pad, and making a perfectly sound and gas-tight joint. By reversing the motion of the lever, the holding-down clutches are released, lowered vertically, and then slightly rotated to such a position that they clear all flanges—thus allowing the cover to be freely raised and travelled away. With this form of fastener the cast-iron flanges of the purifier around the openings are kept quite clear of all bolts or obstructions.

Clapham's "Eclipse" Fastener.

Clapham's patent "Eclipse" rubber joint and rapid automatic fasteners are also operated by a steel shaft, which is octagonal in section, and runs the full length of each side of the cast-iron raised flange or fender-plate round the openings, passing through cast-iron lugs or brackets which form stiffeners to the frame. Each bracket is bored to admit a turned collar, in which is a hexagonal hole for the shaft; and the collars revolve in the brackets. Between each pair of collars is a turned eccentric with hexagonal hole, through which the shaft passes. A swan-head catch is raised or drawn down by the eccentric, the hexagonal shaft passing the full length, raising or drawing down the series of eccentrics and catches at one and the same time—the catches falling back when liberated, to allow the cover to be lifted without hindrance. The catch is adjusted to the position required by means of a bolt which is screwed through it.

In making the cast-iron curb or raised flange separate from the overhanging plates on the top of the purifier, Messrs. Clapham claim that they strengthen the top plates thereby, and reduce the number of joints which come in contact with the rubber; and fixing the holding-down apparatus to the curb reduces the weight of the covers, which is an important item. They also place the strain of fastening on the cast-iron curb instead of on the covers. Their patent also gives them the option of gearing-up with bevel wheels; but they have not used this method, as they do not consider it of sufficient importance, and it also increases the cost. The "Eclipse" rubber joint is both substantial and novel, giving the required elasticity to overcome this difficulty.

Further General Remarks.

In the case of small purifiers, I should prefer to keep to the water-lute, unless some form of automatic fastener could be adopted, as a cover simply held down by ordinary bolts and nuts is anything but satisfactory, and likely to leak unless it is pitched very close. This means a very annoying experience and loss of temper by the manager of small works, who personally has his work cut out to attend the various duties devolving upon him throughout the day, and has not the men or the time at his command which those in charge of larger works have.

There are some works where water-lute purifiers have been converted into luteless ones. This is done by a special casting which fits into the water-lute and runs all round. The rest is quite simple; being only a repetition of previous descriptions. In these conversions, new purifier covers are always required, as the old ones cannot be made use of. Very often, on completion, the water-lutes are filled with concrete flush with the top; and this makes a first-class job.

The "New Century" purifier cover has the advantage that it gives rigidity and protection to the rubber when the covers are removed, and also reduces the waste-gas space in the opening.

Different Forms of Grids.

In addition to the details of purifiers and covers in fig. 1, you will notice that it also shows various forms of wood grids. The

old style of wood grid, with its hardwood frame and bars spaced about ½ inch apart and distance-pieces between, all tightened up with ⅝-inch bolts and nuts, is now used as a support for the latest ideas in grids. The Jäger grid is composed of wood bars triangular in shape, spaced as shown, each grid containing six bars with end-pieces about 12 in. by 10 in. to hold them together in suitable lengths. The Cutler grid is very similar in construction, except that, instead of the grids as a whole being horizontal, they are vertical; the bars being similar to the Jäger, but fitted into upright end-pieces about 5 inches wide and of a depth to suit the purifier the grid is intended to fill. When these grids are fitted into a purifier, they split it up into a number of different sections. The Spencer grid is also upright, but when in position it reposes at a slight angle; and the bars, instead of being triangular in shape, are rounded on the under side. These grids all have a projecting piece top and bottom, which will allow various ways for the gas to pass along. There are other types of grids; and they have been tried at the Granton works by Mr. Herring, but he has replaced them by the arrangement of two grids shown on the diagram, and previously described in detail.

The Milbourne Purifiers.

In addition to the before-mentioned purifiers, there are also Milbourne's patent purifiers, in the design of which external valves can be avoided, and the passage of the gas is controlled by valves embodied in the construction of the vessels. The purifiers are of the luteless type, the gas-tight joint between the cover and the purifier being made with an india-rubber pad similar to that already described. Some of the advantages claimed for these purifiers are as follows: No external centre-valve or slide-valves required; economy in ground space; convenience of addition or extension; and connection reduced one-half; discs controlling the flow of gas worked from the top of the purifier; greater uniformity in connection; number of special pipes reduced by one-half; no connections between valves and purifiers; time in changing purifiers greatly reduced; and inlet pipes protected from falling. The purifying material as well as the main inlet and outlet can enter at any desired position along the length of the purifier—thus saving special bends and pipes.

The Changing of Purifiers.

The great variety of changes that can be made in any set of four purifiers are as follows: All four on in rotation, any purifier first; three on and one off; two consecutive purifiers on, and the other two off; and any single purifier on, and the other three off. The whole set can be bye-passed by the addition of a single slide-valve. The necessary drainage can be provided for in the pipe-lines or at the yard syphons which precede and follow the purifiers.

Purifier Inlets and Outlets.

Special inlet and outlet pipes fitted with valve-discs control the gas passage from and to the trunk mains, and from purifier to purifier. There is a lower inlet-pipe connecting with the inlet mains, and an upper inlet-pipe connecting from the upper outlet of the adjoining purifier. Between these a valve-disc is provided, with a screwed spindle passing through a stuffing-box and gland, fixed on the top plates. This spindle is raised or lowered to close either the upper or the lower inlet as desired. The outlet column is of ordinary construction, but is fitted internally with a lower outlet-pipe connecting to the outlet-main, and an upper outlet-pipe connecting to the upper inlet of an adjoining purifier. Between the upper and lower outlet the gas is controlled by a valve-disc, as described for the inlets.

It will be readily seen, from this arrangement of inlets and outlets, that the gas can be admitted from the inlet-main to any purifier which has the disc raised from the lower inlet, and the upper inlet closed. The gas passes under the inlet hood to the underside of the lower tier of sieves, where it diffuses itself over the entire area of the purifier, then through the purifying material, down the outlet column, and through the lower outlet to the outlet-main, or through the upper outlet to the inlet of the next purifier, according to the position of the valve-disc. It will thus be seen that, by adjusting the discs, the gas can be passed through any number of purifiers; and when it has arrived at the last one, it is passed through the main outlet to the station meter.

When the purifiers are arranged in a line, a return box is cast on the side plates connecting the upper outlet of the fourth or last purifier with the upper inlet of the first of the series. When they are arranged in square formation, this box is not required, as the fourth or last purifier always adjoins box No. 1.

Some Figures as to Cost.

With regard to the cost of the several purifiers, there is not much difference between the small water-lute and luteless kind; the contrast being greater in large installations.

Approximate Costs.

A set of four luteless purifiers, 12 feet square and 5 feet deep, with lifting apparatus, connection, and Clapham's patent fasteners, would come to	£664
A similar set with Milbourne's patent fasteners	660
A similar set in water-lute purifiers	671
A set of four luteless purifiers, 25 feet square and 5 feet deep, fitted with Milbourne's 18-inch valves and connections, lifting apparatus, and Milbourne's patent fastener for covers, would cost	2100
A similar set with Clapham's patent fastener	2170
A similar set in water-lute purifiers	2326
A similar set converted from water-lute to luteless, including new covers	700

In conclusion, the author read an extract from Mr. Fletcher W. Stevenson's "Modern Appliances in Gas Manufacture," with reference to Mr. Henry Green's luteless purifier, a complete installation of which on a large scale is in use at the Grimesthorpe station of the Sheffield Gas Company. It consists of six purifiers, each 70 feet long and 40 feet wide, arranged in two lines. The three in each line are joined together without a break, forming a box 210 feet long; two cast-iron division-plates being inserted to separate one purifier from another. The cost of these purifiers erected complete, including connections, valves, lifting apparatus for the covers, and the columns and girders forming the floor on which the purifiers are carried, was £14,678. The cost of purifiers of equal area with water-lutes and large covers, calculated at the same prices, would be £18,825, or an increased cost of £4147, while the house in which they were placed must have been made larger to permit of water-lutes on all sides.

[The paper was illustrated by diagrams and models; and for the loan of the latter the author expressed his indebtedness to Messrs. C. & W. Walker and Messrs. Clapham Bros.]

Discussion.

Mr. R. W. Cowie (Dalkeith) said it was not often that a paper was illustrated by models in the way the one they had just heard had been; and these had lent very considerable interest to Mr. Hutchinson's communication. They could not have understood the various methods of fastening the covers had it not been for the models and numerous drawings and illustrations. He was struck with the decision of Mr. Herring with regard to the various forms of grids in the purifiers. He (Mr. Cowie) had had no experience of these different grids; but he had seen some of them in other works, and it seemed to him that they would take a great deal of time to clean, whenever the purifiers were being emptied. The arrangement of Mr. Herring, which was found to be better than the patented grids, appeared to be a very simple one. If it overcame the difficulty of back-pressure, its not being patented, and being easily made by any intelligent workman, it might be well to adopt it. A question he would like to ask with regard to Mr. Herring's grid was whether the oxide was harder than in the Jäger grid. It seemed to him it would become hard unless the weight were taken off it. Then the purifiers in Edinburgh were 6 ft. 3 in. deep; and if there were only 3 ft. 6 in. of oxide in them, surely the purifiers were not being worked to full capacity. One thing in favour of Mr. Herring's grid was shown by the time that it took to empty a purifier. Mention was made of steam not being required in order to keep the water-lutes from freezing; but, as a matter of fact, if the purifiers were open to frost and wintry weather, they could not very well get away from the use of steam, because it was almost necessary to keep them at a constant heat of about 60° Fahr.; otherwise the oxide would not work so well, and they would have to change purifiers in the winter, when they could do without this by using steam. He had had some experience with luteless purifiers. He had occasion to put in two purifiers, 8 feet square, the covers of which were flat steel plates with T-iron edges, and the bolts were fitted as described by Mr. Hutchinson. He had no trouble, nor, he believed, had his successor, with the joint giving way. These two small purifiers were laid on a concrete foundation, and the flanges were internal. To have left them as they were would have entailed considerable trouble in clearing out the lime or oxide; and to save this the bottom was filled up with cement and gravel to the depth of the flange, so that the bottom was a thoroughly flat surface.

Mr. R. B. Waddell (Dunfermline) said that Mr. Hutchinson had spoken of a back-pressure of from 14-10ths to 20-10ths. He supposed that back-pressure was thrown by each purifier, and that, therefore, if there were (say) eight purifiers in the works, the total back-pressure due to them would be from 11·2 to 16 inches. In Dunfermline they had adopted Spencer grids. They had four purifiers; three being at work and one off, in rotation. At present they had only one set of Spencer grids at work—viz., in the last box. The back-pressure thrown by the three purifiers in rotation was: No. 1, at the inlet, 55-10ths; No. 2, 57-10ths; No. 3, 48-10ths. In Nos. 1 and 2 there were two layers of oxide, each 14 inches thick, giving 28 inches of oxide in each. In No. 3, where the Spencer grids were the depth of oxide was 3 ft. 6 in., and the back-pressure thrown by that purifier was 6-10ths, compared with 13-10ths by No. 1 and 15-10ths by No. 2. They hoped to still further reduce the back-pressure when all three purifiers were working with Spencer grids.

Mr. W. Ewing (Lochgelly) said he had listened attentively to Mr. Hutchinson's paper, and he could assure members that it was one which a young man could lay aside and refer to at any time. He would find it very useful, more especially if he was about to exercise his mind upon construction. Mr. Hutchinson took them through the whole field of purifiers, from the old to the newer systems, and showed them what was in operation at the present time in the most important, and, to his mind, the finest works in Great Britain—those in Edinburgh. Mr. Herring had introduced a method of purification which could be quite easily followed. There was no patent in it. He himself did the same thing (only he did not use an additional grid) with lime, many years ago, when he first took up duties after he came back from abroad. He put lime into the purifiers, and everybody told him it would never do. He used to fill the boxes with lime. He started with 18 inches on the lower grid, and filled up to the top; and even with Scotch lime he saved much in money and trouble.

The purifiers went three, sometimes four, times as long as they had done previously. Mr. Herring's method should be emulated by everyone. Anybody building purifiers of small size might, with advantage, add another inlet, so that he could put the gas in either at the top or bottom; and if there were a complete set of six purifiers, two catch-boxes would keep them safe. He had designed both kinds of purifiers—the water-lute and the newer system of the Green type—with very successful results. A 30 ft. by 40 ft. purifier went for eight months without cleaning; but he had only two boxes. He wanted six; but, unfortunately, circumstances did not permit of this number, and he made the best of the two. It being an innovation, he put lime in the last box; and he passed gas through up to 300 million cubic feet very successfully. Had he had a complete installation of six purifiers when he started, he believed he could have gone a year or two without opening them. In using oxide of iron, he saved upwards of £900 when compared with the old system of lime purification.

The PRESIDENT remarked that Mr. Hutchinson had brought before them many things worth storing for future use. He had dealt with purification mostly as applied to the oxide method, though those who still kept to the older plan of lime purification would not fail to have benefited by the paper. One thing which struck him during the reading of it was the minute way in which every little detail was gone into. Not only was this the case, but the reason was given for the details of construction. Mr. Hutchinson had discussed in order the different types of purifiers, their advantages and disadvantages, and, what was more important, had gone thoroughly into the cost of each type. Compared with other parts of gas-works plant, the method of purification would seem not to have marched with the times. The ordinary lute purifier had done, and still did, admirably well the work allotted to it; but he thought it was the feeling of all connected with the gas industry that they were in need of improved methods, so far as purification was concerned. The luteless form of purifier seemed to be gaining favour among engineers; and, as Mr. Hutchinson had pointed out, much could be said in its favour. He (the President) had not had any personal experience of the working of this type of purifier; but he could see that it possessed many advantages compared with the older type. One of the drawbacks to the luteless purifier, he understood, had been the way in which the rubber joints were affected by the crude gases, and the loss of elasticity through the pressure exerted on screwing down the cover. These difficulties seemed to have been overcome by a specially prepared rubber. Were he in a position to put down a new set of purifiers, he would give the claims of the luteless form serious consideration, though he would not think of converting a good serviceable set of luted purifiers into the luteless form. He understood that in some of the places where this form was in use a seal-pipe was fixed to the purifier, and was so arranged that excessive back-pressure would blow the seal, and at the same time the escaping gas was led right into the atmosphere—in this way preventing any possibility of explosion. Mr. Hutchinson had demonstrated that not only was the form of the purifier undergoing a change, but also that of the lute inside it; the newer forms having for their object the bringing into closer contact of the gas and purifying material and giving a more equal distribution of the weight. Along with other members who had spoken, he wished to express his thanks to Mr. Hutchinson for his interesting paper, and for the trouble he had taken in procuring the models and preparing the diagrams before them.

Mr. HUTCHINSON, in closing the discussion, said that at Granton the depth of the oxide was 5 ft. 6 in. from the bottom of the purifier; and that the difference in the time taken to empty the purifiers was accounted for by the number of wood grids which had previously to be taken out. It was quite true that there might be some trouble, in the case of small purifiers with rubber joints, in fastening them down; and he knew before Messrs. Clapham's fastening came out, the joints used to come off. He thanked the members for the good reception they had given his paper.

At the close of the business, the members were entertained at tea in the Crown Temperance Hotel—Mr. J. KINCAID, the Gas Engineer and Manager at Kirkcaldy, presiding.

Mr. J. R. MOYES (Edinburgh) proposed a vote of thanks to Mr. Kincaid for the kindness and hospitality he had shown towards the members.

Mr. KINCAID expressed disappointment that he could not get to the meeting till late; but he said he had had the opportunity previously of reading Mr. Ewing's address and Mr. Hutchinson's paper. Mr. Ewing had had a wider experience than most of his colleagues, and therefore his words of counsel were worth listening to. With regard to Mr. Hutchinson's paper, his opinion was that, even though the Association did nothing more this year than receive this contribution, the session would not be unprofitable. The paper would be a reference one both for seniors and juniors.

Mr. Scott's Paper on "The Repair of Gas-Meters."—In the remarks of Mr. M'Ghee on this paper, as given in the "JOURNAL" last week, it should have been stated that unless a rotary meter was passing a minimum of about 70 (not 70,000) cubic feet an hour it was unreliable. In Mr. Scott's reply on the discussion, his statement in regard to the late exhibition was that one 500-light meter (not 500 meters) stood out for a year.

GAS AND ELECTRICITY WORKS AS CROSS-COUNTRY POWER SUPPLIERS.

The October number of "Technik und Wirtschaft"—a magazine issued monthly by the Association of German Engineers, contained an article by Herr Kobbert, the Manager of the Gas-Works at Königsberg, dealing with the economic problems involved in the establishment of central works for cross-country power supplies.

Herr Kobbert first refers to the competition of the last quarter-of-a-century between the gas and electrical industries, and which competition, he says, has been restricted in places where both the gas and electrical undertakings are the property of the municipality by a peaceful apportionment between the two of spheres of activity, and agreement as to prices to consumers. Where, however, the two undertakings have been in different ownership, the competition has been keen and often bitter. The ultimate result of five-and-twenty years' competition has been to give an assured position to electricity for the distribution of power over large areas from central stations; while there is no serious rivalry with gas-works as centres for the distribution of heat. For public and private lighting, however, great competition continues. Herr Kobbert proceeds to argue that the interests of the two industries are not, however, in reality opposed, but that each can advantageously promote the development of the other. The development of electricity supply has, he thinks, resulted in the needs of the larger power consumers being already met; and an attempt is being made to extend the use of electricity to smaller applications. Gas-works, on the other hand, have already nearly exhausted demands in the direction of supplying gas to small users for cooking purposes, and are entering on a campaign for the supply of heat on a larger scale of consumption. Authorities on hygiene have furthered this use of gas by their propaganda against the smoke nuisance. The progressively increasing centralization of household work due to domestic service difficulties is entailing an extension in the supply of heat from central installations; and in this direction there is an almost illimitable field of activity for the gas industry. Economy of fuel and abatement of the smoke nuisance will be incidental advantages gained by the adoption of heating by gas.

Herr Kobbert next refers to the economic conditions which prevail in East Prussia, which obtains its supplies of coal almost exclusively from England through Baltic ports. He advocates the import of English coal as a return cargo for the timber and grain exported from those ports; and points out that if coal rather than coke, tar, pitch, or sulphate of ammonia, is imported, the industry of the country will benefit by the production of these products from the raw coal on the spot. But the coal must be consumed or utilized in such a way that gas, tar, and nitrogen are recovered from it and are not wholly or partially wasted as smoke. At present about 600,000 tons of coal are imported annually through Pillau and Königsberg; and of this, he estimates that about 100,000 tons represents the weight of volatile constituents, such as gas, tar, and nitrogen. The waste gas alone from this quantity of coal, if utilized in gas-engines, &c., would supply 40 to 50 million units of electricity; while the nitrogen would afford, if recovered as ammonia, about 1250 tons of manure for the benefit of the agriculture of the district.

At present, the capital expended on gas-works is only partially utilized, because the maximum day's production is $\frac{1}{250}$-th to $\frac{1}{300}$-th of the annual production. Thus a gas-works which carbonizes 60,000 tons of coal per annum could, without extending its plant, carbonize 100,000 tons of coal if work were uniform throughout the year. If the gas-works were regarded as a large central station for the supply of heat, and gas were produced continuously in large ovens or chambers and water-gas generators, the plant employed would be considerably simplified and less costly, extensive retort-houses would no longer be required, the distinction between gas-works and coke-works would then no longer be marked, and the central generating stations for the cross-country supply of power would become the chief consumers of the gas. In this way, the electricity and gas works would become colleagues rather than rivals. The imported coal employed on gas-works for the supply of central electricity power stations would serve to open up the resources of the interior of the country, and facilitate the industrial employment of peat and timber in districts which are at present more or less inaccessible and undeveloped.

A French patent has been taken out by Dr. Kreidl and Herr Heller for the preparation of pure thorium nitrate for use in incandescent gas lighting. An abstract of the specification in the "Journal of the Society of Chemical Industry" shows that the thorium compound is converted into the salt of an organic derivative of sulphuric acid—for example, ethyl-sulphuric acid—and this salt is purified by fractional crystallization. The differences in solubilities of the ethyl-sulphates of thorium and its impurities are greater than in the case of the sulphates. The pure ethyl-sulphate is converted into hydroxide, and finally into nitrate; and it is stated that a small admixture of the ethyl-sulphate with the nitrate is of advantage, since it gives a bulky oxide on calcination.

WATER SUPPLY TO A LARGE TOWN.

In the Philosophical Hall, Leeds, Mr. CHARLES G. HENZELL, M.Inst.C.E., the Water-Works Engineer to the Corporation of Leeds, last Wednesday delivered his Inaugural Address as President of the Association of Yorkshire Students of the Institution of Civil Engineers. His subject was "The Work of an Engineer with Regard to the Distribution of Water to a Large Town."

After a few prefatory remarks specially addressed to the younger members of his audience, Mr. Henzell said the first great problem which faced the water-works engineer to-day, and one which had been emphasized by the dry season of 1901, was the provision of an ample reserve supply of water for times of accident or drought. This provision was made by means of large storage reservoirs, in which filtered water was reserved, generally under cover, in order that rain and the soot and dust from the town might be prevented from contaminating it. The domestic water supply had, of course, to be of the purest, and should be frequently tested, both bacteriologically and chemically. A fair proportion of carbonates was desirable, as they counteracted the risks of lead-poisoning. In Leeds, the proportion of carbonates was barely sufficient; and if it were only a very little less, particular precautions would have to be taken to obviate the chance of lead salts being dissolved in the drinking water of the city.

With a town supplied by gravitation, it was often necessary to pump the water to the higher levels. It was then essential that a reserve supply should be kept in service reservoirs at a considerable height, so that if any accident happened to the pumps the high levels might still be served. The mains of a large town were always divided into sections, with valves so arranged that, in case of fault in any one section, it could be cut off without depriving the consumers on the other sections of their supply.

An efficient department for the detection and prevention of waste was a very great asset in the maintenance of an economical system of distribution. Waste was detected in two ways—the first being by means of a systematic house-to-house inspection by day, and by an organized system of testing at frequent intervals of all mains and services by night. By the former, leakage from consumers' fittings could be detected and located; with the latter, waste from the pipes could be located and immediately repaired. The second method of waste prevention was by the Deacon meter system, which meant that the town was divided up into sections, and at the quietest period of the day the quantity of water passing through each section was measured by a meter. From this amount all the known consumption was deducted; and thus the wastage was obtained. But the same system of house-to-house inspection as in the first method was also necessary. By the adoption of such measures in Leeds, a waste of 3 gallons per head, or 1½ million gallons per day, had been found and remedied.

Yorkshire Junior Gas Association.—We learn from the Hon. Secretary (Mr. Edward Garsed, of Elland) that the next meeting of the Association will take place on Saturday afternoon, in the Chemical Lecture Theatre at the Bradford Technical College, by permission of the Principal. The President (Mr. F. Scholefield, of Dewsbury) will deliver his Inaugural Address, after which a discussion on Mr. Shepherd's address given last January will be opened by Mr. P. Ward, of Frizinghall.

Chemical Industries at the Turin Exhibition.—We learn that a large number of applications have been received for space in the British Industrial Court at the forthcoming Turin Exhibition, and that there is every promise of a thoroughly representative display of the various industries of this country. The Chemical Industries Committee of the British Royal Commission are already considering how the recently organized Chemical Court, which attracted so much attention at the Brussels Exhibition, may be improved. The Committee referred to include Sir Boverton Redwood (Chairman), Dr. G. T. Beilby, F.R.S., Mr. J. F. L. Brunner, M.P., Professor Vivian B. Lewes, F.I.C., F.C.S., Mr. Thomas Tyrer, F.I.C., F.C.S., and Mr. Corbet Woodall, M.Inst.C.E. It only requires the hearty support of manufacturers to make the exhibit thoroughly representative and successful.

International Committee on Screw-Threads.—We learn from the current number of the "Journal des Usines à Gaz" that a fully attended meeting of the Committee, on which Mr. James W. Helps represents the Institution of Gas Engineers, was held in Paris on the 19th and 20th ult., under the presidency of M. Coze. The members received a hearty welcome from M. Marquisan, the President of the Société Technique du Gaz en France, and were entertained by the Society at dinner at the Grand Hotel on the evening of the first day. Mr. W. H. Lindley, of Frankfort, the Vice-President of the Association of German Gas and Water Engineers, and Mr. Helps, expressed the thanks of the foreign delegates for the cordiality of their reception. Next day, the members of the Committee of the Society were invited to take luncheon with their guests of the previous evening. Several toasts were honoured; and after a few remarks from M. Marquisan and M. Coze, the sittings for the present year were brought to a close. A report of the proceedings will shortly be sent to the delegates for submission to their respective societies, with the view of calling another meeting if necessary.

REGISTER OF PATENTS.

Gas-Meters.

HIBBERD, C. E., of Victoria Street, S.W.

No. 23,551; Oct. 14, 1909.

This invention, relating to dry gas-meters, has for its object to provide means for rendering the parts of the mechanism readily accessible for purposes of inspection or repair, and for ensuring accuracy.

In dry gas-meters, it has been customary heretofore, the patentee points out, to mount the slide-valve mechanism in the casing above the measuring devices, and the plate bearing them has been fixed to, and formed part of, the meter casing. Under these conditions, the replacing of a valve-seat or any repair in such parts necessitated the unsoldering of the entire valve apparatus. It has been proposed to minimize this disadvantage by mounting the valve-seats upon a detachable base-plate made removable from the rest of the apparatus. But even under these conditions, it is necessary, in order to remove the valve gear and the plate, to uncouple the whole of the crank connecting rods and the slide valve rods from the vane rods, and then, further, to undo the screws connecting the plate to the rest of the meter. It has also been proposed heretofore to provide independent valve-seats, or make them up in one element readily detachable from the valve gallery. But in all such constructions, to remove or replace the valve-seats, it is necessary to disturb other of the operative parts of the meter.

According to the present invention, however, the valve-seats are rendered independently accessible. It is only necessary to remove the one which it is desired to repair or replace, and none of the operative parts are disturbed in such a way as to render readjustment necessary on reassembling. This is attained by mounting the valve-seats upon the plate supporting the valve mechanism so as to be readily detachable therefrom, and disposing the valves and other parts so in relation to the plate that it is at most only necessary, in order to remove the valve-seat from the meter, to slacken the guide-rail or equivalent part for positively guiding the valve (which is preferably provided) or like part, and to disconnect a simple connection. The construction of the measuring chambers forms no part of the present invention; this feature being dealt with in a copending application No. 26,425 of 1909.

Treating Coal Gas for the Removal of Cyanogen.

WILLIAMS, P. E., of Leytonstone.

No. 23,624; Oct. 15, 1909.

This invention relates to "treatment for the removal, in soluble form and practically free from iron, of cyanogen from coal or other gas of the kind wherein such gas, also containing ammonia and sulphuretted hydrogen, is, in the presence of water, brought into contact with sulphur.

Hitherto for such purposes, the patentee points out, there has been employed apparatus for treating tar-freed gas comprising a horizontal cylindrical water-containing scrubber having fixed vertical partitions with central openings; free sulphur being delivered as required to the compartments formed by such partitions, and through which there passes a shaft carrying rotary brushes for each compartment. The ammonium sulphocyanide formed is removed from time to time; treated for purposes unconnected with this invention; and as often returned to the scrubber until it is sufficiently concentrated.

The present invention has for object to entirely obviate the necessity for the use of sulphur other than that obtained in the ordinary course of coal-gas purification, as well as to dispense with any apparatus other than is ordinarily employed in gas purification and to obtain the ammonium sulphocyanide in strong solution by a single treatment.

The gas (say, coal gas) is brought, in a suitable vessel, into contact with spent oxide of iron in a moist state, whereby the ammonium sulphocyanide produced is obtained as a strong solution which drains to the bottom of the vessel containing the spent oxide, from which it can be removed and treated for the recovery of the cyanogen. The spent oxide may be formed in the vessel in which it is used, by previously passing through the vessel coal gas free from ammonia but containing sulphuretted hydrogen.

The gas as it leaves the exhauster, and after the removal from it of tar, traverses, preferably in an upward direction, a mass of spent oxide in a moist state; the mass of material being supported within a closed vessel above a perforated plate or grid arranged above the bottom of the vessel which is adapted to form a receptacle for liquid—the gas to be treated being admitted to the lower part of the vessel and the treated gas withdrawn from the top. The ammonium polysulphide formed by the action of the ammonia and sulphuretted hydrogen in the gas upon the free sulphur in the mass forms, with the moisture present in the gas and in the mass of material, a strong solution of ammonium polysulphide, which extracts the cyanogen from the gas so as to form therewith (for the most part) a solution of ammonium sulphocyanide, which drains into the receptacle in the bottom of the vessel, from which it can be withdrawn and treated for the extraction of the cyanogen therefrom, and also, it may be, for the recovery of ammonia and sulphur.

The gas treated as described may then be passed on for treatment in the ordinary washing plant and the purifying boxes containing oxide of iron, in the ordinary way, to remove therefrom the remaining ammonia and sulphuretted hydrogen, or be utilized for the preparation of strong ammoniacal liquor for the recovery of sulphur from spent oxide and like material, as described in patent No. 596 of 1909.

The patentee (who does not illustrate his specification) claims: (1) In the removal, in soluble form and practically free from iron, of cyanogen from coal gas containing ammonia and sulphuretted hydrogen by subjecting the gas to the action of water and sulphur, bringing such gas into contact with spent oxide of iron in a moist condition substantially as described.

(2) In the removal of cyanogen from coal gas according to claim 1 causing the gas under treatment to flow in an upward direction through a moist mass of spent oxide of iron, whereby there is obtained a strong solution of ammonium sulphocyanide.

Manufacture of Incandescence Mantles.

Société Francaise de Chaleur et Lumière, of Levallois-Ferret, France.

No. 5262; March 2, 1910. Date claimed under International Convention, March 5, 1909.

It is a well-known fact, the patentees remark, that "mantles made from artificial silk are more flexible and better sustain shocks and vibrations than mantles made from ramie and cotton; on the other hand, they present the inconvenience that their manufacture is delicate and difficult, that they lose rapidly their illuminating power, and that they withstand badly the operation of coating them with collodion." It is further pointed out that mantles made from ramie and cotton, if indeed, they are less resistant to shocks and vibrations than those made from artificial silk, their manufacture is much simpler, they preserve better their illuminating power, and, since they can be coated with collodion, they are better adapted for transport.

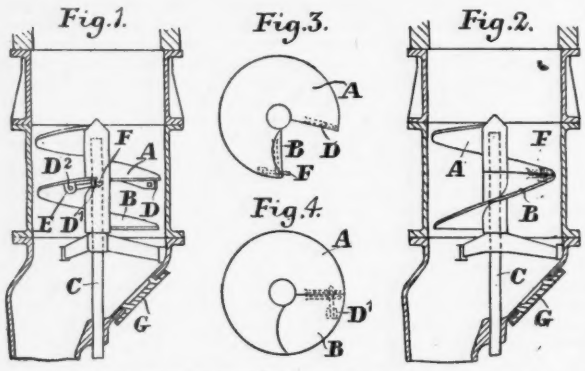
The patentees' proposal is to select artificial silk or analogous material made from cellulose and cotton or ramie as the two fibres for the manufacture of their mantles—a mantle fabric being in this way composed both of ramie and of artificial silk. In this particular case, the artificial silk is said to give the mantles the power to resist shock and vibrations, while the ramie renders them easy of manufacture, adapted to preserve their illuminating power, and to be coated with collodion. These two kinds of thread may be associated, it is pointed out, in various proportions and in various manners. They may be merely associated in the knitting or weaving of the mantle, or may be twisted together or combined to form a single thread in any other manner. The fabrics thus obtained are then impregnated, incinerated, and coated with collodion in the usual way.

Vertical Retort Discharging Apparatus.

West, J., of Southport, and Glover, S., of St. Helens.

No. 6067; March 10, 1910.

This invention relates to the construction of a helix or worm discharging apparatus applied for the purpose of discharging vertical retorts. It has for its object the construction of the worm in two sections; so that one half can be partly rotated on its axis or spindle to such an extent that a free space is made which will permit the inspection of the retort and afford ready access to the retort when it is required to be scurfed or cleared from carbon deposits—the scurfing tools being inserted through the space between the two halves of the worm. When the worm is in action for discharging the retort, the two halves are joined together and held together by a catch, which can be released in a ready manner through an inspection hole provided in the coke chamber.



West and Glover's Vertical Retort Discharging Apparatus.

Fig. 1 shows the worm divided. Fig. 2 shows the two halves of the worm coupled together by the catch. Fig. 3 is a plan of fig. 1, and shows the opening obtained by separating the two sections or halves of the worm. Fig. 4 is a plan of fig. 2.

The worm, as shown, is made in two parts A and B; the former part being free to revolve on the shaft or axis C, while the part B is secured to the shaft. The motion of the shaft, when the two parts are coupled together, causes the worm to revolve as though it was constructed in one piece. D and D^1 are lugs cast on the faces of A and B; and E is the eye-bearing for the pin D^2, which holds the catch F. G is an inspection door in the coke-receiving chamber below the worm discharging apparatus, and through which access is obtained to the worm for the purpose of releasing or fixing the catch when it is required to separate the two halves of the worm, and also to permit the inspection of the retorts and the insertion of the scurfing tools.

Manufacture of Ammonium Carbonate.

Bueb, J., and Deutsche Continental Gas Gesellschaft, of Dessau, Germany.

No. 9177; April 15, 1910.

The process, in accordance with the present invention, consists in causing gaseous ammonia, carbon dioxide, and steam to react together by heating the gases separately at temperatures above that at which ammonium carbonate can be produced; the quantity of steam employed being varied in accordance with the amount of ammonia the required salt is to contain.

The process is carried out as follows: The gaseous ammonia, carbon dioxide, and steam, in about the proportions in which they exist in sublimated ammonium carbonate, are heated separately to a temperature above that at which ammonium carbonate can be produced, and are mixed by being passed through a tube of small bore. The hot gases are led into a sublimating chamber, which is cooled from the outside, and has suspended or supported therein hollow plates or the like, which are cooled internally for the purpose of further increasing the cooling effect. The precipitation and formation of solid ammonium carbonate takes place immediately the gases enter the sublimation chamber, and become cooled to below 60° C., the ammonium carbonate then depositing in thick crusts on the walls and cooling surfaces formed by the hollow plates.

It has been found that the quantity of steam used is inversely proportional to the ammonia contents of the salt obtained. It is accordingly possible, by a corresponding regulation of the steam supply, to vary the ammonia contents of the ammonium carbonate to be prepared. The amount of carbon dioxide in the salt remains practically constant in this case—about 50 per cent.—whereas the amount of ammonia ranges between about 20 and 40 per cent. If, for instance, ammonia and carbon dioxide be subjected to the action of but very little steam, a salt is obtained which contains above 40 per cent of ammonia. By increasing the quantity of steam relatively to the amount of ammonia, it is possible to produce salts containing a proportionately less and less percentage of ammonia, so that an ammonia content of nearly as little as 20 per cent. can be obtained.

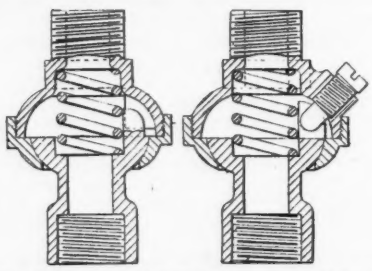
The patentees conclude their specification by stating: Special advantages of an economical nature are secured in the present process by separately isolating from the ammoniacal liquors of gas-works large amounts of ammonia, and the carbon dioxide contained therein; both bodies being thereupon caused to form ammonium carbonate by treatment in accordance with the process of this invention.

Ball-and-Socket Joints.

Falk, Stadelmann, and Co., Limited, from a communication by Andor Barella, of Berlin.

No. 12,848; May 26, 1910.

These ball-and-socket joints have each member of the joint provided with internal projections the two sets of which engage for preventing the axial rotation of one member of the joint relatively to the other member, while at the same time leaving the parts of the joints free to partake of the usual oscillatory movement.



Barella's Cup-and-Ball Joint for Gas-Fittings.

As shown, a single lug or projection (a "tongue") on one member of the joint (say, the ball member) enters between a pair of lugs or projections (a "fork") on the other member of the joint. Ample space is left in the fork, into which the tongue projects, to allow of the oscillatory movement of one member of the joint relatively to the other member, but not to permit of any rotation. The tongue may be integral with the member of the joint to which it is applied, or it may be in the form of a screw which can be fixed in position after the members of the joint have been connected. A sketch of each arrangement is given.

Manufacture of Sulphate of Ammonia from Moist Gases.

Collin, F. J., of Dortmund, Germany.

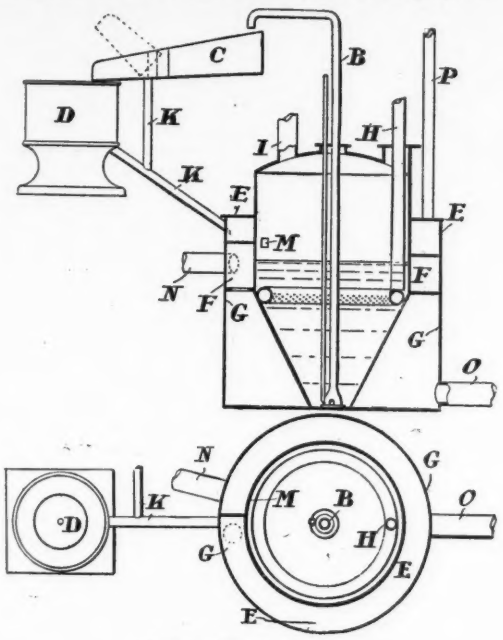
No. 16,193; July 6, 1910.

In the various direct processes for obtaining sulphate of ammonia from hot gases of carbonization by introducing these gases into sulphuric acid, there is (the patentee states in his specification) the drawback that if the temperature of the gases is kept too high the separation of the tar therefrom is made difficult, while at lower temperatures, which favour the separation of tar, there is condensation of water in the acid bath through which the gases pass, which tends to dilute this bath. Efforts have, he says, been made to keep the temperature of the gases as high as possible; and, to prevent the condensation of water in the acid bath, steam coils have been placed therein. It has, however, been found that these arrangements are unsatisfactory, inasmuch as the tar does not separate completely at the higher temperature, and certain of the lighter oils of the tar remain in the gases. These oils are removed from the gases when the latter pass through the acid bath, contaminate the bath, and are rendered less valuable. Furthermore, the heating of the bath by the steam coils is costly and difficult to carry out, because, "so far, no material has been found which will sufficiently resist the action of the hot acid," and the amount of steam used is very considerable.

By the present invention, these disadvantages are said to be avoided by heating the acid bath from the outside, and at the same time heating the mother-liquor which comes from the sulphate of ammonia when it is drained on the drip table and in the centrifugal machine, before it re-enters the saturator, and by concentrating this mother-liquor through the evaporation of part of its water.

The saturator shown is surrounded by an outer shell or jacket G,

forming a space F through which hot gases, hot vapours, or hot air are passed in order to externally heat the saturator, and which gases may be subsequently treated in the saturator. The gases are conducted in such a way that the zone of the saturator in which the separation of the ammonium sulphate takes place is heated first; and the lower portions of the saturator are afterwards heated by the same gases. For this purpose, the space F can be subdivided, horizontally or spirally, as often as may be desired, in order to obtain the greatest amount of heat from the gases. The heating gases enter through the tube N and leave at O. It is not necessary to heat the bottom of the saturator, as the steam of the steam-ejector employed gives sufficient heat for this purpose.



Collin's Sulphate Saturator.

The operation for obtaining sulphate of ammonia from the gases of carbonization is as follows: The gases are first cooled sufficiently to remove the tar as far as desired. They then enter the saturator through the tube H and leave again through the tube I, passing through sulphuric acid, or a solution of acid, on their way, and leaving behind the ammonia they contain in the form of sulphate at the bottom of the saturator, which is removed by the steam-ejector B on to the drip table C. The mother-liquor which is removed with the solid salt returns to the saturator through the tube K, together with the mother-liquor which comes from the centrifugal machine D in which the sulphate of ammonia is dried. This mother-liquor then runs into the evaporating trough E, which is heated from below by the hot gases or hot air passing through the space F around the saturator, and some of its water is evaporated—the vapours leaving through the pipe P. The mother-liquor thus concentrated re-enters the saturator through the opening M.

In this way, it is possible to allow the gases of carbonization to enter the acid bath at a comparatively low temperature, because, in the first place, there is very little condensation of the moisture contained in the gases in the acid bath, owing to the external heating, and, secondly, because the mother-liquor returning from the drip table C and the centrifugal machine D to the saturator is concentrated by passing through the trough E over the top of the heating jacket G.

APPLICATIONS FOR LETTERS PATENT.

Application for Restoration of Lapsed Patent.

C. Burnett has made application for the restoration of the patent granted to him for "Improvements in apparatus for cooling, screening, and loading coke," No. 12,508, bearing date June 16, 1905.

25,209.—Thorp, T., F., & H. T., "Anti-vibrating supports." Oct. 31.
25,254.—Ross, E., "Mantles." Oct. 31.
25,312.—Constantinescu, G., "Carburetting air." Oct. 31.
25,332.—Dyer, W. C., and Ritchie, S. S. & H. E., "High-speed internal-combustion turbine." Nov. 1.
25,336.—Macklow-Smith, A., "Gas-calorimeters." Nov. 1.
25,412.—Brook, F. H., "Valves and cocks." Nov. 1.
25,442.—Thompson, R., "Tap." Nov. 2.
25,504.—Soddy, F., "Separation of mesothorium from monazite sand, and for the concentration of mesothorium in crude products obtained from minerals containing thorium." Nov. 3.
25,585.—Chandler, D., "Gas-lamp galleries." Nov. 3.
25,607.—Reid, F. T., "Time mechanism for gas-valves." Nov. 4.
25,716.—Wyld, W., "Distillation of ammoniacal liquor." Nov. 5.
25,739.—Higgins, W., and Kemp, G. H., "Inflammable spirit for use in the manufacture of illuminating gas." Nov. 5.
25,767.—Eaglesham, J., and Campbell, M. D., "Cooling coke, coalite, and like substances." Nov. 5.

Henry Howarth, of Bradshaw, was found on his bed with the end of some piping, which had been attached to the gas-bracket, in his mouth; the gas being turned on. Deceased had been depressed for some time, and was under the care of a doctor. At the inquest, a verdict of "Suicide while temporarily insane" was returned.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Carbonizing Results.

Sir,—The capital paper, on "Carbonizing," read by Mr. Harris last March before the Midland Association, together with the excellent discussion to which it gave rise a week or two ago, makes really most interesting reading, and will provide much food for thought and careful deliberation to those who, in the near future, are contemplating extensions of carbonizing plant.

The yield of gas per ton of coal, as well as the make per mouthpiece, quoted on behalf of this, that, and the other system causes one to wonder when, if ever, finality in these directions will be ultimately reached. When comparing such quoted results, however (in connection with this particular paper and the discussion later), the thought occurred to me that probably these figures were not wholly comparable one with another, though they may be on the broad grounds of quantity produced and illuminating (or calorific) value. What about temperature and pressure when registering the quantity made—more particularly the former? It is generally recognized that makes of gas should be corrected to the standards of 60° Fahr. and 30 inches barometer; and it seems to me that, when stating results obtained, it would enable truer comparison to be made, and the values of the several systems to be better appreciated, were such done and so stated, or were it always understood that it had been done. On most important works' correction of volume on account of these two factors is systematically made; but, unless similar adjustment is effected by those giving their carbonizing results, it appears to me that the figures so quoted are really worthless as a reliable means of comparison.

Margate, Nov. 11, 1910. J. M. Campbell.

Brick and Concrete Gasholder Tanks.

Sir,—I have read Mr. Herbert W. Alrich's paper submitted to the American Gas Institute last month, of which you publish the first portion in this week's "Journal." The paper contains some criticisms of the one I read in November last before the Manchester Association of Students of the Institution of Civil Engineers, on "The Design and Construction of the Large Gasholder Tank at Manchester," which was designed by the Chief Engineer, Mr. J. G. Newbigging, M.Inst.C.E. With your permission, I should like to deal with some of the points Mr. Alrich has raised with reference to this paper, which was one dealing also with "the principles governing the design of gasholder tanks in general"—the one at Manchester having been already designed and simply used as an illustration.

Mr. Alrich first questions the figure of 220 lbs. per square inch (31,680 lbs. per square foot) used for the ultimate resistance to tension of brickwork in 1 : 3 cement mortar, and mentions that Trautwine gives 220 lbs. per square inch as the "average ultimate tensile resistance of brick" alone. My figure of 220 lbs. per square inch for brickwork in cement mortar, 1 : 3, is obtained from Mr. Thomas Newbigging's "Gas Manager's Handbook." Rankine gives 280 to 300 lbs. per square inch for brick alone. Taking this for brick, and 175 lbs. for 1 : 3 cement mortar given by Mr. Alrich, we have about 227 lbs. per square inch as the value for the combination. This averaging is approximately correct, as the cross area of the joints *plus* the area of the bond are nearly equal to the sectional area of the bricks in the wall.

Later, Mr. Alrich says, in reference to my methods of calculating the strength of masonry tanks by dividing the wall into segments: "The summation of the moments of stability of these was assumed as co-operating with the tensional resistance of the ring in resisting the bursting pressure." I assumed nothing of the sort, and cannot believe that such tension exists where a puddle-backing is used behind a porous wall. Further examination will show that circumferential tension in the wall was not mentioned. In fact, the question of tension in the ring due to water pressure is all dependent on the earth backing, and the method of keeping the same tight up to the wall. In the case of the Manchester tank, the puddle was well rammed and watered as it was deposited between the wall and the undisturbed ground, which was good and very firm. The puddle thus provided a tight filling—being put in as the wall rose; so that when the wall was completed, and no water was in the tank, a compression stress was produced in the ring, which would be further augmented by the puddle being kept wet for the whole time. When the water was run in, the effect would be to restore equilibrium; for the water would soak through the brickwork, and the pressure would be met by the puddle and the hard clay behind.

In taking one section of the tank as a dam, the whole structure was assumed to be well knit together. Not that the piers were independently stable, but that some assistance is obtained from the circular form of the structure and its properties as a monolith; the possibility of the failure of one section between the piers being allowed for, because it is the weakest part of the wall and would therefore fail first.

Perhaps Mr. Alrich would point out where my formulæ "ignore the most elementary principles of analytical mechanics, and the laws of Nature as well." Also, in what way they "offend ordinary mechanical instinct." He is certainly the first person to refer to them in this way. A little more investigation on his part would, I think, show him that they are based on the elementary laws of moments, similar to those in use for retaining walls.

With reference to his remarks on my assuming the backing to have the same resistance at all depths. I would ask him to again consult Newbigging's "Handbook," where he will find that the resistance per square foot for clay is 1200 lbs. average, which is the figure that I have taken. In England, the safe load usually allowed on clay for foundation work is 1½ tons or 3360 lbs. per square foot as a maximum. Allowing for this at the greatest depth and nothing at the surface of the ground, we have 1680 lbs. as the average safe resistance to compression per square foot. The figure of 1200 lbs. is, therefore, very much on the right side. Mr. Alrich's reference to shaving off the uppermost

layer of earth, 1 inch thick with a pressure of 100 lbs. per lineal foot, is thus misleading. Further, in this case the earth would be subjected to a purely shearing action on the lower edge of the strip, and not to a simple compression stress as is the case lower down.

Personally, I consider the most severe stresses come on a masonry tank immediately after completion, when the tank is empty and the wet puddle and surrounding ground are pressing hard on the "green" tank wall—tending to burst in one of the sections between the buttresses by breaking the bond of the section at the piers. Reference to my paper will show that I have dealt with this, and have obtained a factor of safety of 7·7 for the Manchester tank.

This tank has just undergone a severe test. It was filled with water eleven months after the completion of the brickwork—taking 68 days to fill. It was then allowed to stand filled a few days after absorption had ceased, and was then emptied. Examination failed to detect any signs of failure, or cracking.

The value of any formula is judged by the way it is borne out in practice. The formulæ submitted in my paper, therefore, cannot be very wide of the mark.

The American tanks mentioned by Mr. Alrich as having diameters of 185 feet and depths of 42 feet, with walls 7 and 8 feet in thickness, show a most extravagant use of material. A tank of this size in England would have a wall no thicker than 3 ft. 10½ in. at the outside, unless the ground were very bad.

Mr. Alrich in his calculations assumes that there is maximum ring-tension at approximately the centre of water-pressure. This may be perfectly true for a tank above ground. But does such tension come into play so long as the earth behind the wall is pressing thereon with a pressure equal to, if not greater than, that of the water on the other side, and thus putting the wall in equilibrium? I contend that it does not.

Lastly, Mr. Alrich considers that he is justified in assuming an ellipticity of ½ inch per 100 feet of tank diameter, and the proceeds to calculate the extra stress caused by this ellipticity. Seeing that this ½-inch is but 0·00041 of the total diameter, or about three times the depth of the inequalities in a well-built brick wall, it is, to say the least of it, cutting things too fine for practical purposes, especially when dealing with brickwork. In common parlance, it seems like "splitting hairs."

There are many more points in his paper with which I should like to deal, but I have already trespassed on your space sufficiently.

FRANK H. ROBINSON, Assoc.M.Inst.C.E.

Manchester, Nov. 11, 1910.

LEGAL INTELLIGENCE.

GAS COMPANIES AND PRIVATE ROADS.

Redhill Gas Company Summoned.

A case of considerable interest to the gas profession, and one in which an important point of law was raised, occupied the attention of the Reigate County Bench on Saturday, when the Redhill Gas Company were summoned at the instance of the Surveyor to the Reigate Rural District Council for "that on the 25th day of July, in the parish of Merstham, the Company, being the undertakers within the meaning of the Gas-Works Clauses' Act, 1847, unlawfully did open and break up a certain street there called Albury Road, without giving such notice as is required by the Statutes in that behalf to the Rural District Council of Reigate, or to their Clerk, Surveyor, or other officer, of the intention of the said Company to open and break up the same, contrary to the provisions of the Gas-Works Clauses Acts and the Statutes of the said Company."

Mr. W. W. MACKENZIE appeared for the District Council; and Mr. A. A. METHUEN represented the Gas Company.

Mr. MACKENZIE briefly explained the powers of the Company with respect to the opening of roads, but pointed out that the Act provided that three clear days' notice should be given to "the persons having the management or control of the streets" in which such work was carried out. As this was not a private lane or street defined by Statute, the Company were bound to give this notice; and section 9 of the Act further stated that plans should be submitted, and that the work should be carried out in accordance with such plans. The penalty for every offence was one not exceeding £5. There was no doubt this was a thoroughfare for public passage within the meaning of the Act.

The CLERK: Is there any question as to whether this road has been dedicated to the public?

Mr. METHUEN: I do not dispute there is a public right of highway over the road; but it is not a highway repairable by the inhabitants. That is the real point. It is a private road.

Mr. MACKENZIE said the portion of the road in dispute was dedicated by the owners to the public six years ago.

Mr. METHUEN: "Dedicated to the public" is a very awkward expression to use. What happened was that the owners dedicated to the public a right of passage over this road. The real point in the case is whether they can require us to give notice in respect of a road which is not repairable by the inhabitants at large.

Mr. MACKENZIE argued that the District Council had "control" over the road because it was an obligation imposed upon them by Statute to prevent an obstruction. Six years ago, the owners agreed to dedicate the road to the public; and the road was made up in accordance with plans submitted to the District Council and under the superintendence of the Council's Surveyor. The Council also took a sewer down the road at the expense of the public. Before 1835, any land laid out as a highway and used by the public instantly became repairable by the inhabitants of the parish, now represented by the District Council. In 1835, it was found from experience that so many highways were laid out in this way, especially in towns, that a great burden was placed upon the ratepayers in repairing new streets. It was then enacted that no highway should be repairable by the parish unless the street was formally made up to the satisfaction of the surveyor and approved by two justices. This Act did not affect the question as to whether or not it was a public highway. It still left the matter where it was—namely, that a public highway was one over which the public had a right to pass.

The CHAIRMAN (Sir J. Colman, Bart.): Do you claim the absolute right of the District Council to control any road or path dedicated to the public?

Mr. MACKENZIE: Yes.

Formal evidence having been given,

Mr. METHUEN, on behalf of the Gas Company, said this was a very important matter. It was not a question merely as to whether they had to give notice in respect of streets which were becoming town streets, but whether they had to give notice in respect of any land over which there might be any right of public highway. It was an enormous question. This was not an urban district, but a rural district; and constantly there were calls to take gas up to a private house where they might have to go under a footpath and lay their pipes. If his friend's contention was right, they would have to give notice, submit plans, and wait for the inspection of the Local Authority in each instance before they could carry out such works. After all, it was not merely a question of convenience. The real point which he would ask the Bench to decide was, Had the Rural District Council any right to require notice or plans in respect of a road not repairable by them? He submitted they had not. This land was not vested in the public. In the case of *Harrison v. Duke of Rutland*, the plaintiff, in order to uphold what he deemed to be the rights of the public, stood upon a path over which there was a right-of-way on the Duke of Rutland's land. Harrison was removed from the highway; and an action for trespass was then brought. The Court of Appeal held that Harrison was a trespasser, because the right to pass over the land was the only right the public had. The duty of the District Council was to protect the public rights; but this did not refer to the road itself. His learned friend could not show a single thing which gave the District Council the right to interfere with the road. They had no property in it.

Mr. METHUEN, in reply to the Clerk, said the owners were the proper persons (if any) to receive this notice; but he did not think it was necessary under the Gas-Works Clauses Act.

Mr. MACKENZIE said it was a startling proposition that, in the case of a public highway not repairable by the public, no notice was necessary.

The BENCH, after a brief consultation, said there must be a conviction, and imposed a fine of £2 and costs. Upon the appeal of Mr. Mackenzie, they awarded the District Council 15 guineas costs.

Mr. METHUEN: Your Worships will state a case?

The CHAIRMAN: Certainly. It is a very important question, and a proper case to take further.

Unsuccessful Claim against Messrs. Gibbons Bros.

At the Wandsworth County Court last Tuesday, before his Honour Judge Harrington and a Jury, George Simmonds, a labourer, sued Messrs. Gibbons Bros., Limited, of Dudley, for £150 compensation, under the Employers' Liability Act, for injury caused when employed by them at the Wandsworth Gas-Works on the 22nd of July. Plaintiff, with two other men, was engaged in unloading a cart full of iron pipes about 4 feet long, and from 6 to 12 inches in diameter, when the first pipe lifted off the cart slipped and struck him on the right knee. He had to go to the Bolingbroke Hospital, and attended there till the 13th of October. He subsequently went to St. George's Hospital. He had not been able to do any work since the accident. Mr. R. Griffiths, a surveyor, said he thought the method of unloading the cart was unsafe. Dr. Bouck, who examined the plaintiff on the 16th of August, said he was suffering from what was practically a sprained knee, and this would prevent him lifting heavy weights. He would, however, be well in three months. For the defence, Dr. Fergus, House Surgeon at the Bolingbroke Hospital, said that when plaintiff came to that institution on the 22nd of July he had some water on the knee, and there was a small abrasion on the right side of the knee. He was an out-patient till Oct. 13, when witness thought he had practically recovered and was fit for work. Dr. W. Cooke, who examined the plaintiff on Oct. 6, said he considered plaintiff would be able to return to work in a fortnight. In cross-examination, he said he thought the man was shamming pain. Arthur Parish, the defendants' foreman, said the weight of the pipe which fell was 1 cwt. 1 qr. 18 lbs.; and it was perfectly proper to unload such pipes by hand and in the manner in which those in question were unloaded. The two men who were working with the plaintiff having given evidence as to how the accident happened, George Gatland, a yard foreman in the service of the Gaslight and Coke Company, corroborated the statement of Mr. Parish as to the method of unloading the pipes. The Jury returned a verdict for the defendants; saying they thought the action ought never to have been brought. His Honour concurred; and judgment was entered accordingly. Mr. Wilde, who appeared for the defendants, agreed to Simmonds being awarded compensation under the Workmen's Compensation Act; and he was allowed £12.

North Oxfordshire Water Company, Limited.

Last Saturday, Mr. Justice Warrington made the usual order in respect of this Company in a debenture-holder's action, which came on as a short cause on motion for judgment. Mr. Thorpe appeared for the plaintiff.

Water Supply Scheme for Heacham.—At the Public Hall, Heacham, last Tuesday, Mr. W. O. E. Meade-King, M.Inst.C.E., held an inquiry into an application made by the Docking Rural District Council to the Local Government Board for authority to borrow £6250 for the purpose of providing a supply of water for the parish of Heacham, in accordance with a scheme prepared by Mr. E. Herbert Stevenson, who explained its details. There was no opposition.

MISCELLANEOUS NEWS.

PRESENTATIONS TO MR. W. R. HERRING.

His Farewell to Edinburgh Employees.

On the evening of Tuesday last, Mr. W. R. HERRING, on retiring from the position of Chief Engineer to the Edinburgh and Leith Gas Commissioners, was the recipient of valuable presentations—the gift of the employees and workmen under him in the offices and works. The ceremony took place in the Technical Office. There was a large attendance of the workpeople, for whose convenience a special train was run from and to Edinburgh.

Mr. A. MASTERTON, who succeeds Mr. Herring as Engineer, presided. The occasion, he said, was a unique and eventful one for their guest, and they had met to wish him God-speed in his new venture.

The CHAIRMAN, at a later hour of the evening, said it was with the greatest pleasure, not unmingled with regretful feelings, that he had undertaken the duty requested of him that night. It had been his privilege to have been at many gatherings since he became connected with the gas industry, but this one was unique in its character, because it was the ending of an important chapter in the annals of their professional history. They had reached a transition stage, on the platform of which they looked back to the past and forward to the future. Naturally, many changes had taken place during the thirteen-and-a-half years of Mr. Herring's administration. Old things had passed away, and a new and more important era had been entered upon at the Granton works. When Mr. Herring came north among them, they predicted that he was the right man in the right place, and that they were fortunate in getting him as their chief. He had not disappointed them. He had proved a good friend to them all, as they could testify. As regarded his capabilities, they had only to become acquainted with the organization and details of the magnificent work which he had designed and brought to completion. Men of note had usually monuments raised to them after they had passed away; but Mr. Herring had erected one in his lifetime, which would be seen by generations yet unborn. He had had many opportunities, in their acquaintance, of forming an opinion of Mr. Herring's character; and he felt it would be wrong of him if he omitted to say a few words, although he knew that Mr. Herring would rather that he did not. He would pardon him when he gave this testimony—that they had ever found him thoughtful and generous in his dealings, considerate and just in business, and fair and honourable among the employees. They had noted more than once his keen judgment and unbending strength of principle, allied to his clear perception of duty, and the power to decide promptly. He had often had complex and difficult questions to solve, subjects of a varied and delicate nature requiring a cool head and a quick understanding to consider them. He had faced these difficulties with a masterly mind; and he had never had to acknowledge defeat. Although he was leaving the old, familiar place, he was not severing his connection with them entirely. They should gladly welcome his advent among them from time to time, with hearty enthusiasm. They should follow him in his future career; and, judging from their knowledge of his work in the past, they had every confidence that he would meet with unparalleled success. He had their best wishes for this, and also for good health and strength. He had now to ask Mr. Herring, in the name of the officers and employees—in short, of all those who had been under his jurisdiction—to accept a silver rose bowl as a token and proof of their respect and esteem, and as a lasting remembrance of their past association. With unfeigned pleasure he turned to Mrs. Herring, and begged that she would accept, from the same sources, a silver salver, as an evidence of their goodwill and regard for her. They trusted that she would find pleasure and comfort in her new home, and be long spared to her husband and family. With the greatest heartiness he handed over the gifts to Mr. and Mrs. Herring. He called upon those present to join with him in drinking to the long life, health, and prosperity of Mr. and Mrs. Herring and the children.

The inscription on the rose bowl was:

> "Presented to W. R. Herring, Esq., Member of the Institution of Civil Engineers, on the occasion of his retiring from the position of Chief Engineer and Manager to the Edinburgh and Leith Corporations Gas Commissioners, by the officers and employees, as a token of their respect and esteem. Edinburgh, 11th November, 1910."

The inscription on the salver was to the same effect, with Mrs. Herring's name substituted.

Mr. HERRING, on rising to respond, was greeted with great enthusiasm. He said that no man could find himself in the position in which he found himself that night without being moved by the very heartiness of their reception. Mr. Masterton had in most gracious terms referred to him, to his work, and to his association with them; and he had also told him of the spontaneous character of the suggestion, which came from themselves, that they would not allow this incident in his life to pass without marking it indelibly upon his mind. This they had undoubtedly done. Not only had they asked him to accept, on behalf of his wife and himself, very handsome and costly gifts, but the manner of their giving was, if possible, even greater than the gifts themselves. He had, as Mr. Masterton remarked, been with them now rather more than 13½ years. It was unique, as Mr. Masterton remarked, if they remembered that so much change had taken place during this time in the organization of the undertaking. It had just occurred to him that not a single department of the great undertaking was as it was fourteen years ago. The works were changed, and the other departments were all changed; not even one of them being now housed in the same quarters as they were at the beginning of his term of office. In making these changes, it had been inevitable that there had been a little rough ground to traverse; but, on the whole, and with the concurrence and the expressed wish of the Commissioners, they had, as far as practicable, made provision for the comfort and wellbeing of those who carried on the operations. He thought it could be claimed that they were all working under more comfortable and more healthy conditions than in the old days. It was also gratifying to him to know that the changed conditions were appreciated in the respective departments. It was not easy, in carrying on a work such as this, to make provision as far as perhaps one would wish for the comfort and welfare of those around them. But, as employees, they had been fortunate in having over them a body of business men, in the persons of the Gas Commissioners, who had always been ready to see the necessity of studying the welfare of those they employed; and it did not need him to remind them of what had been done for the employees of the undertaking. The sick fund had been encouraged to the extent of backing it, should it ever be found necessary to back it, by the funds of the Commissioners. But what he thought was of even greater importance was the provision that had been made for the retiral of those in their employ—optionally at 60, but compulsorily at 65. He had always realized, in every undertaking with which he had been connected—gas and otherwise—that it was a very hard case for an employee to be working ten, twenty, thirty, and perhaps forty years for an employer, and then, when he became too old to work, or was enfeebled by sickness, to have nothing to look forward to but his own scanty savings, and which he had to rely upon just at the time of life when he ought to have less care for his future than at any other period. Fortunately, in their case, this had now been provided for them; and on a scale which they must consider liberal. There were many who had retired on the full scale; and he was glad to see several of them there that night, hale and hearty. One thing which had surprised him more than another was the large number who could have retired at 60 on the full pension scale, but who had preferred to be allowed to work on. Although they could add nothing to the amount of their pension, they preferred to work on so long as they felt fit for their work. This was an indication as to how the employment was appreciated. He had referred to the rough ground which it had been necessary to traverse in making the changes which had been made in the organization of the undertaking; and it occurred to him that they might look upon the whole organization as an arch. An arch, as they knew, was made up of a great number of individual pieces. There were so many pieces on the face of the arch, seen by every passer-by; there were a larger number of pieces under the surface; and there was a still greater number beneath. These were all unseen. Yet every piece was playing its part; and without each individual member, the other members could not do their part. This was the position with themselves. Some were seen on the face; others had to be looked for under the surface; others they knew were there, but they could not see them once they were placed in position. He had had the honour of being for years the keystone of the arch. It was an honour that he had very much appreciated. It was a position that he had been proud to fill; and he could not vacate it without deep feelings of regret, for it had been a very important epoch in his life. Some years ago, he would have spurned the idea of ever allowing fate or destiny to move him on; but they were not masters of their own destiny. Something had moved him on, and, as they knew, he was going; but he was glad to see—and he appreciated it very much indeed—that the Commissioners had found a way of retaining his services in their employ, and not, as it were, cutting him adrift from his own child. His heart had naturally been built in this great undertaking. He was going to say that every brick and every rivet had formed part of his thoughts at the time it was necessary to place them. It was impossible for one to break away from such an association without feelings of real regret. In again thanking them for their handsome gifts, he could not say more than that he did sincerely thank them. They should show them to their friends, as a memento of their life there; and they should hand them to their children, both of whom, he was going to say, knew about as much about Granton as they did themselves. His little daughter, when she was but five years of age, in quite an informal ceremony, laid the first brick of the gasholder tank. He himself carried her on his shoulder down the plank. Then his little son, he also without ceremony, laid the first brick of the second section of the works. He could assure them that his children had taken as great an interest in the works as anybody could have done. Their whole lives, so far as their memories were concerned, had been spent at Granton; and he knew they had spent many happy days there. They would therefore associate with this event and ceremony and the sight of the lovely gifts, their childhood's recollection of their father's work.

At the call of the Chairman, three cheers for Mr. Herring were given with great heartiness. Mr. Herring, it was explained, was obliged to leave, as he was going to London that night. As he moved from the table, taking farewell of those beside him, the audience sprang to their feet and burst into the pathetic Jacobite song, "Will ye no' come back again." Immediately afterwards, Mr. and Mrs. Herring, attired for travel, emerged from the dressing-room; and as they walked down the hall, the handshaking on all sides was hearty and continuous. Having reached the door, Mr. Herring turned, and for a second or two surveyed, with evident emotion, the still more emotionally moved assemblage; then, with a wave of good-bye, he passed out and disappeared from his followers and his friends in the North.

The CHAIRMAN, at a later stage of the evening, proposed the toast of "The Gas Commissioners," which was responded to by Judge Bryson, the Convener of the Works Committee, and by Judge Inches, the Convener of the Finance and Law Committee. The former stated that Mr. Herring, before he went away, asked him to say, what he had forgotten, that he had been the keystone of the arch, but that Mr. Masterton was now filling that important position—that Mr. Masterton was now the keystone of the arch which held the whole thing together, and that he hoped they would give the same service to Mr. Masterton that they had given to him.

Mr. M'GILLIVRAY, Works Foreman at Granton, proposed the toast of "The Chairman," which was duly acknowledged; and the proceedings, which had taken the form of a concert, given by the employees of the Commissioners, and had been very cheerful throughout, were brought to a close at half-past ten by the singing of "Auld Lang Syne."

OLDHAM GAS-WORKS EXTENSION.

Inauguration of the New Four-Lift Spiral-Guided Holder.

The Chairman and Members of the Oldham Gas Committee invited a number of gas engineers in Lancashire and adjoining counties to be present at the inauguration of the four-lift spiral gasholder (described and illustrated in last week's "JOURNAL," p. 392) which has been erected at the Higginshaw Station by Messrs. Robert Dempster and Sons, of Elland; the ceremony being fixed for Monday of last week. In the early part of the afternoon, the company assembled at the entrance to the Hollinwood Gas-Works, and having inspected them proceeded to the site of the tank which is now in course of construction for a spiral-guided holder that will have a capacity of 5¼ million cubic feet, a description of which was published in the "JOURNAL" for Aug. 16 last (p. 455). From Hollinwood the party travelled by tram to the Higginshaw station for an inspection of the new holder.

Mr. J. W. BROADHEAD (of Messrs. R. Dempster and Sons), before asking Alderman Thompson, J.P., the Chairman of the Gas Committee, to turn on the gas from the new holder to the town mains, explained that the new holder, which had replaced a two-lift holder, though not the highest of its kind in the world, was the highest in proportion to its diameter. Since it had been inflated, it had stood the test of several rather severe storms. When a gale was blowing at the rate of 90 miles an hour, with a pressure of 40 lbs. to the square foot, a total pressure of 178 tons would be exerted on the holder if fully inflated. To meet this pressure, each of the carriages (36 in number) round the tank would have to stand a pressure of 5 tons; but each carriage was capable of standing a pressure of 20 tons. He had to congratulate the Chairman and the members of the Gas Committee on their progressive policy, which he hoped would be more than amply justified. He then asked Alderman Thompson's acceptance of a handsome silver rose bowl as a memento of the occasion.

Alderman THOMPSON, in tendering his thanks, said it had always been the endeavour of the Committee to keep up with the times; and much of the success of the undertaking was due to the carrying out of this policy. The old gasholder, which had been displaced by the new spiral-guided one, was erected 39 years ago, and brought into use the following year. It had a capacity of 400,000 cubic feet; and by the new holder the storage capacity had been increased by 375,000 cubic feet. The reason why the Committee decided upon having a spiral-guided holder was on the score of expense; and the only anxiety they had was whether this system for a four-lift holder would stand wind and weather. However, on the information obtained from experts, and also on the advice of their Engineer (Mr. T. Duxbury), the Committee came to the conclusion it would be quite safe to adopt the spiral-guided system, which meant a saving to them of £1000. The new holder had already stood the test of wind and weather, and proved its stability; and he felt satisfied that it would answer the purpose for which it had been erected. It would be known as the "Elland Holder," because the Contractors had their works there. The Committee were entirely satisfied with the way in which the Contractors had done their work; and he hoped the holder would be a credit to them.

A DINNER.

Alderman Thompson then turned on the gas from the new holder to the town mains. The party having inspected the plant in use at the Higginshaw works, returned to Oldham by special trams, and were entertained at dinner at the Town Hall. Alderman Thompson presided; and those present included the Mayor (Alderman Schofield), the Town Clerk (Mr. J. H. Hallsworth), the General Manager of the Gas and Water Departments (Mr. A. Andrew), the Gas Engineer (Mr. T. Duxbury), and the Works Superintendent (Mr. J. Dudley).

After the toast of "The King" had been submitted from the chair and duly honoured,

Mr. ISAAC CARR proposed "The Oldham Gas Committee and Success to the Undertaking." Having observed that if spiral-guided gasholders were well anchored in solid ground, there was no reason to have any fear as to their safety, he said the Oldham gas undertaking was in the forefront of those in this country. When they came to consider the magnificent works they had inspected that day at Hollinwood and at Higginshaw, it was evident that no money had been spared where money was wanted for the improvement of the plant, so that the manufacture of gas could be carried out with efficiency and with cheapness. It was not surprising, therefore, to learn that they could sell gas cheaply at Oldham; and he hoped they would go still further in this direction. They in Oldham were travelling on right lines; and he wished them every success.

Alderman THOMPSON, responding, said that he and his colleagues on the Gas Committee were delighted to have so many gas engineers and experts in gas manufacture present with them that day. He desired to thank Mr. Carr on behalf of the Gas Committee for the compliment he had paid to them. The Oldham Gas Committee had always tried to keep their works up to the highest state of efficiency; and he was pleased some of the experts present had found something in connection with the works that they could commend. They all recognized that a vast amount of money was sunk in gas undertakings in the country; and they also recognized the great importance of the gas industry. At one time it was thought that electricity would supersede gas for many purposes; but in his opinion there was a grand field for both. Through the adoption of improved stoking machinery, and other things, they had been able to cheapen the cost of production, and manufacture gas at a very low figure. Not only this, but with the aid of improved appliances for consumption, they had a much more brilliant light; and the demand was greater to-day than ever. It was a matter of satisfaction to know that in a number of places the local authority had given up electricity for street lighting and reverted to gas; and it was to the credit of gas engineers that this had been brought about. If the gas industry was to keep its place, they must have gas engineers not only well informed on the subject of gas manufacture, but possessed of a certain amount of commercial knowledge. There were very few callings in life where so many qualifications were necessary as in the gas industry. A gas engineer was, in fact, a marvellous man of knowledge. Not only had he to be conversant with the manufacture of gas, but he had to be a

GAS COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 461.

Issue.	Share.	When ex Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
1,551,863	Stk.	Oct 14	5	Alliance & Dublin Ord. .	88- 90	..	5 11 1
374,000	Stk.	July 14	4	Do. 4 p.c. Deb.	95–98	..	4 1 8
200,000	5	Oct. 28	7	Bombay, Ltd.. . .	6⅜–6⅝	..	5 5 8
40,000	5	.	7	Do. New, £4 paid .	4⅜–5⅛	..	5 9 3
50,000	10	Aug. 31	15	Bourne- } 10 p.c. .	28½–29½	..	5 1 8
311,810	10	,,	7	mouth Gas } B 7 p.c. .	16⅞–16⅞	..	4 3 7
75,000	10	..	6	and Water } Pref. 6 p.c.	14⅜–15¼	..	3 18 8
380,000	Stk.	Aug. 12	12½	Brentford Consolidated	246–249	..	5 0 5
330,000	,,	.	9⅜	Do. New . . .	185–187	+1	5 1 7
50,000	,,	,,	5	Do. 5 p.c. Pref. .	—	..	—
206,250	,,	June 10	4	Do. 4 p.c. Deb. .	93–101	..	3 19 3
220,000	Stk.	Aug. 31	11	Brighton & Hove Orig.	215–218	..	5 0 11
246,320	,,	.	8	Do. A Ord. Stk. .	158–161	+1	4 19 5
460,000	20	Sept. 23	10⅝	British	44–45	..	4 12 4
109,000	Stk.	Aug 11	6	Bromley, A 5 p.c. . .	117–119	..	5 0 10
165,700	,,	,,	4½	Do. B 3½ p.c. . .	88–90	..	5 0 0
82,278	,,	.	5½	Do. C 5 p.c. . .	107–109	..	5 0 11
55,000	,,	June 29	3½	Do. 3½ p.c. Deb. .	85–87	..	4 0 6
250,000	Stk.	,,	4	Buenos Ayres 4 p.c. Deb.	97- 99	..	4 0 10
100,000	10	—	—	Cape Town & Dis., Ltd.	3–4	..	—
100,000	10	—	—	Do. 4½ p.c. Pref. .	4⅜–5⅛	..	—
50,000	50	Nov. 2	6	Do. 6 p.c. 1st Mort.	—	..	—
100,000	Stk.	June 29	4½	Do. 4½ p.c. Deb. Stk.	88–90	..	5 0 0
157,150	Stk.	Aug. 12	5	Chester 5 p.c. Ord. . .	109½–111½	..	4 9 8
1,513,280	Stk.	,,	5⅛	Commercial 4 p.c. Stk. .	105–108	..	4 16 3
560,000	,,	,,	5	Do. 3½ p.c. do. .	101–103	..	4 17 1
475,000	,,	June 29	3	Do. 3 p.c. Deb. Stk.	79–81	..	3 14 1
800 000	Stk.	June 10	4†	Continental Union, Ltd.	88–93	+½	4 6 0
200,000	,,	,,	7	Do. 7 p.c. Pref.	137–139	..	5 0 9
492,270	Stk.	—	5½	Derby Con. Stk. . . .	122–124	..	4 8 9
55,000	,,	—	4	Do. Deb. Stk. . . .	104–105	..	3 16 2
148,995	,,	Oct. 14	5	East Hull 5 p.c. Ord. .	103–105	..	4 15 3
486,092	10	July 14	12	European, Ltd. . . .	23¾–24¼	..	4 19 0
354,060	10	,,	12	Do. £7 10s. paid.	17¼–18¼	..	4 18 8
16,179,445	Stk.	Aug. 12	4⅜	Gas } 4 p.c. Ord. . .	105–106	+½	4 8 0
2,600,000	,,	,,	3⅛	light } 3⅛ p.c. max. .	87–89	..	3 18 8
4,062,235	,,	,,	4	and } 4 p.c. Con. Pref.	103–105	..	3 16 2
4,531,705	,,	June 29	3	Coke } 3 p.c. Con. Deb.	80–82	..	3 13 2
258,740	Stk.	Sept. 15	5	Hastings & St. L. 3⅛ p.c.	92–94	..	5 6 5
82,500	,,	,,	6⅛	Do, do. 5 p.c.	114–116	..	5 12 1
70,000	10	Oct. 14	11	Hongkong & China, Ltd.	17–17½	..	6 5 8
131,070	Stk.	Sept. 15	7⅛	Ilford A and C . . .	145–148	..	4 19 8
65,780	,,	,,	5⅛	Do. B	112–114	..	5 3 1
65,500	,,	June 29	4	Do. 4 p.c. Deb. . . .	98–100	..	4 0 0

Issue.	Share.	When ex Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
4,940,000	Stk.	Nov. 11	9	Imperial Continental .	184–186*	+½	4 16 9
1,235,000	Stk.	Aug 12	3⅛	Do. 3⅛ p.c. Deb. Red.	94- 96	..	3 12 11
200,242	Stk.	Aug. 31	6	Lea Bridge Ord. 5 p.c. .	120–122	..	4 18 4
561,000	Stk.	,,	10	Liverpool United A. .	220–222	..	4 10 1
718,100	,,	,,	7	Do. B . .	163–165	..	4 5 10
306,083	,,	June 29	4	Do. Deb. Stk.	104–106	..	3 15 6
75,000	5	June 29	6	Malta & Mediterranean.	4⅜–4⅝	..	6 3 1
560,000	100	Oct. 1	5	Met. of } 5 p.c. Deb.	59–101	..	4 19 0
250,000	100	,,	4½	Melbourne } 4½ p.c. Deb.	99–101	..	5 9 10
541,920	20	Nov. 11	3⅜	Monte Video, Ltd. . .	123–123⅜	..	5 9 10
1,775,892	Stk.	July 28	4⅛	Newc'tle & G'tesh'd Con.	102–103	..	4 5 0
529,435	Stk.	June 29	3½	Do. 3½ p.c. Deb.	90–91	..	3 16 11
55,940	10	Aug. 31	7	North Middlesex 7 p.c.	143–143	..	4 16 7
300,000	Stk.	Apl. 29	8	Oriental, Ltd. . . .	138–140	..	5 14 4
60,000	5	Sept. 15	8	Ottoman, Ltd. . . .	6–6½	..	6 8 0
31,800	53	Aug. 31	13	Portsea Island A. . .	131–133	..	5 3 0
60,000	50	,,	13	Do. B. . .	124–126	..	5 3 2
100,000	50	,,	12	Do. C. . .	117–119	..	5 0 10
114,800	50	,,	10	Do. D and E.	102–104	..	4 16 2
398,490	5	Oct. 28	7	Primitiva Ord. . . .	7⅛–7⅜	..	4 13 4
796,980	5	June 29	5	Do. 5 p.c. Pref. .	5 1/16–5 1/8	..	4 11 11
488,900	100	June 1	4	Do. 4 p.c. Deb. .	97–99	..	4 0 10
312,650	Stk.	June 29	4	River Plate 4 p.c. Deb. .	97–99	..	4 0 10
250,000	10	Sept 29	9	San Paulo, Ltd. . . .	15⅜–15⅝	..	5 14 3
62,500	10	,,	6	Do. 6 p.c. Pref. .	11¼–11⅝	..	5 2 2
125,000	50	July 1	5	Do. 5 p.c. Deb. .	51–52	..	4 16 2
135,000	Stk.	Aug. 31	10	Sheffield A	229–231	..	4 6 7
209,984	,,	,,	10	Do. B	229–231	..	4 6 7
523,500	,,	,,	10	Do. C	229–231	..	4 6 7
70,000	10	Oct. 14	6	South African	10¾–11¼	..	5 6 8
6,429,895	Stk.	Aug. 12	5/9/4	South Met., 4 p.c. Ord.	121–123	..	4 8 10
1,895,445	,,	July 14	3	Do. 3 p.c. Deb.	80–82	..	3 13 2
209,820	Stk.	Aug. 31	8	South Shields Con. Stk.	155–157	..	5 1 11
605,000	Stk.	Aug. 12	5⅜	S'th Suburb'n Ord. 5 p.c.	120–122	..	4 12 9
60,000	,,	,,	5	Do. 5 p.c. Pref. .	120–122	..	4 2 0
117,058	,,	July 14	5	Do. 5 p.c. Deb. Stk.	121–123	..	4 1 4
502,310	Stk.	Nov. 11	5	Southampton Ord. . .	107–109*	–½	4 11 9
120,000	Stk.	Aug. 12	7	Tottenham } A 5 p.c. .	141–143	..	4 17 11
483,940	,,	,,	5⅛	and } B 3½ p.c. .	112–114	..	4 16 6
149,470	,,	June 29	4	Edmonton } 4 p.c. Deb.	57–59	..	4 0 0
182,380	10	June 10	8	Tuscan, Ltd.	9–9½	..	8 8 6
149,900	10	July 1	5	Do. 5 p.c. Deb. Red.	98–100	..	5 0 0
236,476	Stk.	Aug. 31	5	Tynemouth, 5 p.c. max.	112–114	..	4 7 9
255,636	Stk.	Aug. 31	6⅜	Wands- } B 3½ p.c. . .	139–141	..	4 15 9
85,766	,,	June 29	3	worth } 3 p.c. Deb. Stk.	73–75	..	4 0 0

Prices marked * are "Ex div." † Next dividend will be at this rate.

chemist, an analyst, an architect, and a commercial man as well. He was glad to see that the Universities were taking up this question. There was no doubt that much good would result, and considerable advancement be made in the science of gas manufacture. With reference to the works seen by the visitors that day, he might say that during the past ten or twelve years the Gas Committee had made very extensive alterations and improvements. They had spent big sums of money, and increased their capital account to a large extent. The result of all this had been a considerable reduction in the cost of production, which had enabled them to lower the price of gas. Therefore they had been amply repaid for the outlay; and they were now able to supply gas at 1s. 8½d. to 2s. per 1000 cubic feet, net. Though their area of supply—16,000 acres—had not increased, the number of consumers had gone up year by year. When a boom in trade came, the Committee would be in a position to meet the further demand for gas. At present, they had over 50,000 workshops and houses connected to their mains. He thought he was right in saying that Oldham had one of the most prosperous gas undertakings in the country, and had always been in the forefront. Since they took over the works in 1854, they had paid to the borough fund more than £400,000 in aid of the rates, besides supplying gas gratuitously to the value of over £180,000. Therefore he was right in saying that the gas undertaking had been a prosperous one for the ratepayers. He believed, however, that they were to be prevented from giving so much. They were to be limited to £7500 per annum. What would be the result? The gas consumers would get the benefit in having cheaper gas.

Councillor GOODMAN, in submitting "The Contractors," explained the reasons which led the Gas Committee to erect a new gasholder at Higginshaw, and added that it was the aim of the Committee to give the town as good a supply of gas as possible. The Contractors, he said, had done their work well, and the Committee were perfectly satisfied.

Mr. J. W. BROADHEAD, in response, said that his firm had a staff second to none, and were thus able to turn out good work. It was pleasant to know that their efforts to give satisfaction were appreciated by those they worked for. As to spiral-guided holders, his firm was one of the few that advocated the system; and the figures he gave them at the Higginshaw works were, he thought, sufficient to assure them that, with reasonable dimensions, the spiral-guided holder was absolutely safe. As Mr. Carr had said, if they were well anchored down to the ground, they could not possibly have a mishap. For himself, he believed that the spiral-guided holder would be the thing of the future. On behalf of his firm, he had to thank the Chairman and members of the Gas Committee for many kindnesses received from them. They had found the Corporation very considerate indeed; and in connection with the new holder at the Higginshaw station, he desired specially to express his thanks to Mr. Duxbury and Mr. Dudley for the assistance they rendered the men, so that the contract could be completed to time.

The MAYOR, in proposing "The Visitors," said he and his colleagues were pleased to see such a large attendance of gas engineers from different parts, to take part in the inauguration of the new holder. They claimed to be progressive in Oldham; and he thought what the visitors had seen and heard about the gas undertaking would have gone far to prove this statement.

Mr. R. G. SHADBOLT responded, and observed that he and his colleagues from other towns had been much interested in all they had seen. On behalf of himself and the other visitors, he thanked the Corporation for their hospitality.

Mr. H. KENDRICK also responded, and gave some particulars as to the course of lectures arranged for at the Manchester University on the science of gas manufacture and combustion. He said he was pleased to state that a large number of students were availing themselves of the facilities offered under the scheme.

Councillor H. WILDE proposed "The Officials." In the course of his remarks, he paid a high tribute to the services which had been rendered to the gas undertaking by Mr. Andrew and Mr. Duxbury. He added that the latter had the full confidence of the Gas Committee, and since his appointment had carried out at the works many important improvements for the greater efficiency of the department. Through the influence of Mr. Duxbury, they had at the present time a number of students attending the local technical classes studying the manufacture of gas. He also paid a tribute to the other chief officials.

Mr. DUXBURY, responding, said he had always been well supported by his Committee in the work he had to do.

Mr. ANDREW also replied; and the proceedings concluded with a vote of thanks to Alderman Thompson for presiding.

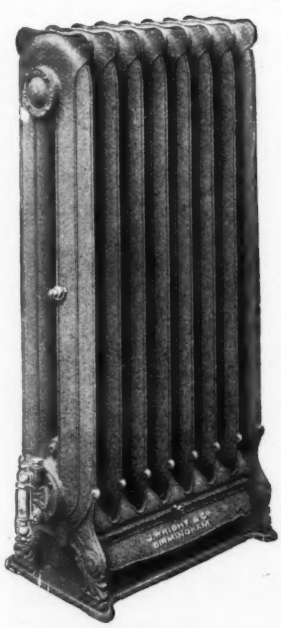
SOWERBY BRIDGE GAS-WORKS EXTENSIONS.

Local Government Board Inquiry.

The Urban District Council of Sowerby Bridge having applied to the Local Government Board for sanction to borrow the sum of £15,900 for the purpose of extending and re-modelling their gas-works at Sowerby Bridge, Mr. R. G. HETHERINGTON, Assoc.M.Inst.C.E., one of the Board's Inspectors, held an inquiry last Wednesday, in the Council Chamber, into the subject-matter of the application. Among those present were the Chairman of the Council (Mr. A. S. Firth, J.P.), the Clerk (Mr. Rhodes), the Chairman of the Gas Committee (Mr. J. W. Whiteley), and the Gas Engineer and Manager (Mr. A. W. Bissell). The application was not opposed.

The CLERK said the Council had been empowered to borrow for gas-works purposes sums amounting to £102,000; and there had been actually borrowed £98,422—leaving unexpended borrowing powers to the extent of £3578. With regard to the £98,422, there had been repaid £85,429; leaving £12,993 still owing. On the whole of the works

The "St. Andrew."



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belonging to the Council—gas, water, sanitary, &c., £197,116 had been expended; and in respect of this, loans totalling £195,255 had been sanctioned, £191,874 borrowed, and £131,912 repaid—leaving £59,962 still outstanding. These figures showed that the Council were in a very sound financial condition. The Sowerby Bridge urban district had an area of 564 acres; but in addition to this the Council supplied gas to the outlying districts of Ripponden, Triangle Richworth, Sowerby, Mill Bank, Soyland, and parts of Luddenden Foot and Norland. The population of Sowerby Bridge in 1901 was 11,475, but was now estimated at 12,200, though the total supplied with gas was estimated at about 24,000. The rateable value of the district for poor-law purposes was £55,832, and for district rate purposes £52,008. The poor-rate was now 3s. 10d. in the pound, and the district rate 2s. 10d.—a total of 6s. 8d. A penny rate produced £202. In consequence of the growth of the population and the increased requirements of the district which had taken place the past few years, the extra demand for gas from inside and outside districts made the gas-works totally inadequate to supply the wants of the gas area. The present works were old and in a dilapidated condition; and should the increased demand continue, great difficulty would be experienced in affording a sufficient supply under present circumstances. Their normal daily capacity was 525,000 cubic feet, and the demand varied from 550,000 to 650,000 cubic feet. The present holder capacity was 670,000 cubic feet. It would be observed that extreme measures and considerable tact had to be exercised to cope with the demands of the district at present. The seriousness of the position made by the unprecedented demand last winter compelled the Gas Committee to consider making the proposed extensions.

Mr. J. W. WHITELEY (the Chairman of the Gas Committee) was then called to submit the proposed scheme. He said that ever since he had been a member of the Council (9½ years) it had been their policy to defer spending money until the original loan was paid off; but the extensions and renewals at the gas-works must not be delayed any longer. The retort-house was 49 years old, and was braced and buttressed up at many points. The benches were also in such a state that it would be penny wise and pound foolish to attempt to patch them up any longer. There were three reasons why the Council should proceed at once with the scheme. First, because the condition of the works, for an annual output of 125 millions, was altogether inadequate and unreliable. Secondly, because the Committee were having an increase in the demand for gas month by month; the output so far this year being 3,300,000 cubic feet in excess of the corresponding period of 1909, while the prospects of a further increase were very rosy, as there was likely to be a larger demand for gas for manufacturing purposes as well as for cooking. Thirdly, because the judicious expenditure of the money asked for would justify the outlay by increasing the efficiency of the works, in carbonizing at a much less cost, and getting very much more gas per ton of coal. The Committee felt that they were only doing their duty to the ratepayers by asking the Inspector to consider the scheme in a favourable light. They had not entered upon the enterprise without investigating the matter. They had consulted other gas engineers, and reports had been made and considered by the Gas Committee from all the places they visited. In the Council there had been an almost unanimous vote in favour of the scheme the Committee were submitting. There might be objections taken to the fact that a portion of the proposed new works would be built on leasehold land. But only two-thirds of the proposed new plant would be on leasehold land; and there were still 44 years to run. If the Local Government Board would grant the Council powers to borrow on a 30 years' repayment, they would have 14 years in hand after the loan had been repaid. He concluded by expressing the hope that the Inspector would get the matter through as soon as possible.

Mr. BISSELL then gave details of the scheme. He stated that during the last eight years they had put the Luddenden Foot works on a proper and satisfactory basis; and the present application was for the Sowerby Bridge works alone. The latter works were in a fair state, except the parts they had to consider specially at this inquiry—viz., the retort-house and benches, the coal-store, tar and liquor tanks, and condenser. These it was proposed to remodel and extend to provide for the present and future, as far as ground space would allow. Then they believed the works would suffice for 25 to 30 years, and by an extension of the retort-bench for a further period, according to what was then put down. The present benches were for producing 525,000 cubic feet of gas daily, against 768,000 cubic feet with the new benches under the same conditions, but with stoking machinery a million cubic feet per day. The average daily demand in winter was from 550,000 to 650,000 cubic feet; and on one dark day they reached 781,700 cubic feet, which was the maximum demand, while 606,000 cubic feet was the maximum make—both occurring last December. The figures of expenditure were: Retort-house, £3400; retort-benches, £6490; elevators, hoppers, &c., £2750; stoking machinery, £1500; water, tar, and liquor tanks, £950; condenser, £450; wheeling platform, £310; removing the station meter and house, and altering the pipes, £200. There would be a small sum realized for old material. Last winter it was necessary to have all the plant working continuously for two months; and he believed the demand for gas had come to stay. There was an increase of more than 7½ per cent. for the half year ending September last, against the corresponding period of 1909. The price of gas had been reduced in Sowerby Bridge from 2s. 3d. to 1s. 9d. per 1000 cubic feet net; in the out-districts, except Luddenden Foot, from 3s. to 2s. 4d. net; in Luddenden Foot from 3s. 4d. to 2s. 4d. net—bringing all the out-districts to one common price. The present application did not include anything for larger gas-mains or gasholder; perhaps this might come up later. The proposed improvements were really needed. Questioned by the Inspector as to the £3084 of loan still unborrowed, the witness said they wanted the money at once in order to pull down the old retort-house and build a new one; any deficit thereon being charged against the new loan. This would carry them on till the larger loan was sanctioned for further extensions.

Mr. FIRTH, Chairman of the Council, supported the application.

The inquiry then closed, and the Inspector signified his intention of visiting the gas-works.

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EXTENSION OF THE BURTON-ON-TRENT GAS AREA.

Purchase of the Barton Gas-Works.

The Burton-upon-Trent Town Council had before them at their Meeting last Wednesday the report of the Gas and Electricity Committee, which contained a proposal that the Corporation should acquire the undertaking of the Barton-under-Needwood Gas Company, with the right to supply gas in their district.

Alderman LOWE, the Chairman of the Committee, in moving the adoption of the report, said that on more than one occasion those who had been interested in the Needwood Company had approached the Committee with the idea that they should acquire their undertaking and supply the gas in Barton. Up to the present they had not considered it to the advantage of the Council that they should do so; but now they believed it would be for the mutual benefit of themselves and the gas consumers if they took them over. After some negotiations, it had been agreed between the Committee and the Gas Company, subject to the approval of the Council, and also subject to their obtaining powers under a Provisional Order of the Local Government Board, to acquire the whole of the Company's assets for the sum of £850. It was arranged that the Barton Company should keep their own book debts and pay their own liabilities. The Council would take over a house, half-an-acre of land, and the whole of the mains, some 2½ miles in extent; and for the sum named they had made a very good bargain. He confessed the Company met them in a very fair spirit, and adopted the line that they would not stand out for any big price, so long as they could get the Corporation to supply Barton with gas at a reasonable figure. The Council would understand that in the assets acquired there would be a ready-money value of between £200 and £300. In order to supply the gas consumers in Barton, it would be necessary for them to lay mains from the borough boundary to Barton Turn, and increase the main by 1000 yards, costing £3000. They proposed to lay mains that would be of such a capacity that they would not only be able to supply gas to the existing consumers, but to meet a considerable increase in the demand for gas which was expected there. Indeed, the mains would be constructed to supply four times the quantity of gas required at the present time. The consumers at Barton were now paying 5s. 6d. per 1000 cubic feet for their gas; and the Committee proposed to supply it to ordinary consumers at 4s. The Council would agree, when he pointed out that at present there were 391 possible consumers in the Barton district, and only 74 of them used gas, that there was considerable scope for an increase in sales. In addition to this, they would be passing through the parish of Branstone, and they hoped to supply the inhabitants of this village with gas at a price to be fixed later. He moved the resolution with every confidence. The Committee also asked the Council to give them power to deal with the matter. It was important that they should not have to consult the Council on every point, because when the Local Government Board Inspector came down, it would be necessary to make one or two decisions on the spot. He had a statement from Mr. Bell, their Consulting Engineer, in which he said they were acquiring the property on very favourable terms indeed.

Mr. LIVENS seconded the motion.

Mr. BASSETT asked what was the consumption of gas annually; what the sales produced; what profit the Company had made; and how long the existing plant had been in use.

Mr. ROWLAND said, as a Council, they required a little more information. They were spreading their area of responsibility beyond their natural boundaries; and if this was a part of their commercial development, he would be glad to hear of it. But they were dealing with a business which was to all intents and purposes a non-paying one; and it was a question whether they were justified in spreading the area of their influence to so wide a district as Barton.

Mr. AUSTIN was also of opinion that the Council required a little more information before giving the Committee the powers they were asking for. The very fact of Barton being unanimously in favour of the scheme seemed to raise a doubt as to whether it was such a bargain as was stated. Moreover, they had had no official or reliable figures upon the matter. He was certainly of opinion that they should have some definite and expert advice as to the condition of the mains in Barton; while as to the value of the works, they would be of little utility to Burton, as they were going to make their gas at home.

Alderman ROWLAND said he saw the position of members desiring fuller information; but, on the other hand, with regard to such matters, when they were negotiating with a number of authorities they could not put before the full Council the whole of the facts. There must be a certain amount of reserve on the part of the Committee, and they must either leave it there or quash the proposal at once.

Mr. THORNLEY pointed out that they were not dealing with the people of Barton, but with a private Company. Before the Committee asked for a free hand, they ought to have obtained a definite census of the people who would consume gas. He was not inclined to take on his shoulders any responsibility. The possibility was that they might have to relay two miles of mains; and the Committee should have given the Council something more definite than they had done.

Alderman LOWE, replying to Mr. Bassett, said the Company's sales last year were 1,668,000 cubic feet, and the profit was £81. The cost of the works now would be scrap price at £2 10s. a ton.

Mr. BASSETT then moved, as an amendment, that the matter be referred back to the Committee for further information. He said the sale of gas at 4s. per 1000 cubic feet would be only £100 a year; and they were asked to give £850 for the works. They would have to spend £3000 on mains, and also attend to the wants of the consumers six miles away. He failed to see where the benefit would be to the people of Burton.

Mr. ROWLAND seconded the amendment.

After some further remarks,

Alderman LOWE, in reply, said that if they obtained the Provisional Order they would have a monopoly of gas supply for Barton and Dunstall. They had now power to go a mile beyond their boundary, and

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there was no reason why they should not supply Branstone. They had not actually canvassed the district; but they were sure to get an increased consumption. They were paying £850 for the works themselves, for which they would get £100 as scrap iron to-morrow; and there were the house and land as well. Alderman Lowe gave various details as to the prospects of the purchase, and urged that the application for the Provisional Order should be made at once.

Mr. Bassett then asked leave to withdraw his amendment; and this was done with the seconder's consent.

The report of the Committee was adopted with one dissentient—Mr. Rowland.

Alderman Lowe then moved the formal resolution sanctioning the application for the Order; and it was carried.

BIRMINGHAM CORPORATION GAS DEPARTMENT.

Action in Regard to the Bank Overdraft.

In the course of the inquiry by the Local Government Board into the question of the proposed extension of the boundaries of Birmingham, considerable notice was taken of what was alleged to be an illegal bank overdraft, amounting to about £300,000, in connection with the Gas Department. The matter is now to come before the Courts for decision, as last Thursday writs were served upon the Town Clerk and the City Treasurer, in an action at the suit of the Attorney-General, who has been set in motion by a ratepayer, calling upon the Corporation to show cause why they should not make good the above-named amount. A general declaration is to be asked for that the appropriation of loan balances as working capital for trading undertakings is illegal. It is stated that the Corporation are prepared to meet the case, as they have been advised that their practice is perfectly good. While it is admitted that there is an overdraft on the revenue account of the Gas Department, there is a credit balance on capital account; and it is claimed that the one balances the other. It is necessary for the Department to have working capital; and they are said to be acting on the powers which were taken over from the Gas Companies. The matter of the loans was raised some time ago, when the question of the inclusion of Yardley in the Greater Birmingham scheme was discussed; and the Town Clerk then explained that there were overdrafts on the water and gas accounts. The borrowing powers of the Corporation, he said, extended to enable money raised in the exercise of them to be utilized for "working capital," and a balance had always been kept, and was still in hand, sufficient for this purpose, with the result that there was, in fact, no overdraft with the bankers, but, on the contrary, a considerable credit. The Corporation had been advised that the West Ham case did not decide this to be illegal, but quite otherwise.

Handsworth has been pointed to as the place of origin of the action; and the "Birmingham Daily Mail" says that while members of the District Council repudiate the suggestion that the Council has in any way instigated the proceedings, it can hardly be doubted that the action is being taken at the instance of a resident of that district. The Council, it is asserted, were in no way responsible for the litigation; and it could not be too clearly understood that not a penny of liability with regard to the matter would fall upon the Council. Birmingham declined to admit that the overdraft was a liability, and contended that they had done nothing which was at all *ultra vires*. This was the point to be settled; and there was no doubt that if the judgment of the Court went against Birmingham the position of affairs would be considerably modified.

MUNICIPAL AFFAIRS AT ST. HELENS.

When returning thanks for his election as Mayor of St. Helens, Alderman Joseph Beecham remarked that in 1900 the rateable value of the borough was £345,000, and the total rates 4s. 9d. in the pound. This year the rateable value was £390,000, and the rates 6s. 10d. This large increase had been caused by expenditure on education, parks, hospitals, sewer works, highways, tramways, &c. In the water department, on which they were not allowed to make a profit, the cost of water both for household and trade purposes had been increased; but this was due to the large expenditure on new works at Melling and the reservoir at Brownedge. The gas-works was an undertaking that had always been ably managed by the Engineer (Mr. S. Glover) and the Gas Committee. In 1900, over 327,000,000 cubic feet of gas were made, against 462,000,000 cubic feet last year. The prices ten years ago were for lighting 2s. 6d. per 1000 cubic feet, and for power 2s.; and now the rates were 2s. 2d. and 1s. 8d., less large discounts. Since 1900, no less than £47,500 had been handed over to the relief of the rates. The electricity works had made rapid strides. In 1900, they sold 113,000 units for lighting to 173 consumers; and they had seventeen motors with a total of 72 H.P., and using 24,800 units. Last year, however, they supplied 420,000 units for lighting, and had 264 motors with a total of 2030 H.P., using over 900,000 units. These figures were for the year ending March 31; but during the past six months there had been an increase of 45 per cent. on the units sold during the same period last year. The total average price obtained in 1900 was 3·42d. per unit, the cost of production being 2·29d. But to-day the average price obtained was 1·48d., and the total cost of production 0·66d. per unit.

Reductions in Price.—The Directors of the Littleborough Gas Company announce that, owing to the increasing consumption of gas for all purposes, there will be a further reduction in price, commencing with the March quarter next year. The new prices per 1000 cubic feet will be: For lighting, 2s. 5d. to 2s. 9d. net; non-lighting, 2s. 2d. and 2s. 3d. net; and engines, 1s. 7d. to 2s. 3d. net. In the case of slot-meters, 4d. per 1000 cubic feet will be returned in cash. As from the 1st ult., the price of gas has been reduced by the Wexford Gas Company from 2s. 9d. to 2s. 7d. per 1000 cubic feet. No meter-rent is charged.

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PUBLIC LIGHTING OF WESTMINSTER.

Offer by the St. James's and Pall Mall Electric Light Company.

At the Meeting of the Westminster City Council last Thursday, the Works Committee reported that the St. James's and Pall Mall Electric Light Company had written to them pointing out that, under the new contract for public lighting, the sixteen flame arc lamps and posts put up in Regent Street remained the property of the Council. The Company suggested that they should be allowed to remove and retain as their own property the arc lamps and carriers, as they were put up on the initiative of the Company at the joint expense of the Council and themselves, each contributing the sum of £145, and had been maintained by the Company at an illuminating power of more than 3000 candles per lamp for the past eleven months at the low rate of £17 per lamp per annum. They stated that at the time of making the new contract the Council could hardly have contemplated so drastic a measure as the forfeiture, after a brief period, of the Company's capital sunk in what was a successful demonstration for the public benefit. It having been intimated to the Company that the Council could not be advised by the Committee to allow them to retain the lamps, the Company in a further letter stated that it was a pity these lamps should be "scrapped," and the mains laid by the Company for the purpose of street lighting allowed to become derelict; that it would be an advantage to the Council and the Company that provision should be left for a continuance of the experiments on this method of lighting (which so far had been a pronounced success), as there was no doubt that in the course of the next five years immense improvements would be made in the distribution of light for important thoroughfares by high candle power electric lamps, and these should not be overlooked by the Council. The Company proposed that they should be authorized to use the existing flame arc lamps and mains, and to erect in Piccadilly Circus three steel posts of approved design, in positions to be selected, each post to be (say) 35 feet in height, and to carry four of the lamps. They offered to provide and erect the posts, erect the twelve arc lamps, and maintain them under contract with the Council for a period of five years, for the full normal hours of lighting under the terms of the Council's specifications and requirements, free of all charge and cost to the Council. The Company expressed the hope that the Council would recognize the *bonâ fide* nature of the offer, which would enable the experiments to be continued for their mutual information. The Company further offered, in the event of any improved lamp or method of lighting by electricity being introduced during the period of the contract, to change over (by arrangement with the Council) to such system. The electric arc lamps proposed to be erected in Piccadilly Circus will not be in place of, but in addition to, the high-power gas lighting to be provided by the Gaslight and Coke Company under the new public lighting contract. The Committee recommended the Council to accept the offer of the Company; and this was agreed to without dissent or discussion.

WARRINGTON WATER-WORKS EXTENSIONS.

Local Government Board Inquiry.

An inquiry was held in the Warrington Town Hall last Friday, by Mr. R. C. Hetherington, Assoc.M.Inst.C.E., one of the Inspectors of the Local Government Board, into an application made by the Corporation for sanction to borrow £23,799 for the purpose of their water undertaking, including the execution of some works in the townships of Burtonwood and Winwick-with-Hulme. The Deputy Town Clerk (Mr. A. T. Hallaway) said the Corporation acquired the water-works in 1890, and nine years later they were extended. The area of supply was 40,000 acres, and there were three systems—a trade supply, a low-level supply, and a high-level supply. The second comprised the whole of the borough and a small portion of Cheshire. The water was supplied by gravitation from two service reservoirs at Winwick. The combined pumping plant raised 2,900,000 gallons per 12 hours; 2,300,000 gallons of this being available for the low-level supply and all future demands. At the present time the low-level system was supplied by an 18-inch main, and it was being overworked. The proposal before the Inspector was to lay another 18-inch main, giving 3 million gallons per day, or a maximum demand of 242,000 gallons per hour. This it was estimated would be ample for the district's requirements for many years. The figures now were 18·45 gallons per head, compared with 22 gallons in 1900. Complaints had at times been received of the scarcity of water. The reasons for the application were, first, that the present 18-inch main was overworked; secondly, that they were not able to supply the higher portions of the borough; and, thirdly—and this had caused the Water Committee very serious anxiety—the danger to the large works and buildings in the town in respect of fire. Part of the application was for £6000 for the laying of mains in the future. Evidence in support of the application was given by the Water Engineer (Mr. J. Gray) and the Medical Officer of Health (Dr. J. Coote Hibbert).

DERWENT VALLEY WATER UNDERTAKING.

Supply of Water to Enderby.

The question of obtaining an improved water supply for the prosperous granite village of Enderby, which lies about 4½ miles to the south-west of Leicester, has for some years engaged the attention of the local authorities. The population have long suffered from the want of an adequate supply, being dependent upon shallow wells, which have been exhausted by the encroaching of the granite quarry workings; and in some cases the sources of water have become impure in quality as well as deficient in quantity. Many schemes were brought forward, but without any practical result. About four years ago, the water question became so urgent that arrangements had to be made by the

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Enderby Parish Council to cart water and distribute it among the inhabitants; but on the Leicester water supply being extended by agreement to the Leicester and Rutland County Asylum, which is in the parish of Enderby, the Blaby Rural District Council approached the Corporation, and arranged for a supply from a hydrant as a temporary measure. Eventually, in April last year, an agreement was entered into with Leicester, whereby the mains of the Corporation were extended to the Narborough Cross Roads; and at this point a supply of water in bulk was sold to the Enderby Parish Council, who were to lay their own mains and distribute the water. The scheme for the distribution of water in the parish was prepared and submitted to the Rural District Council, and application was made to the Local Government Board, who approved the scheme and sanctioned the raising of money to carry out the works. Mr. Charles Chamberlain, of Leicester, was the contractor for the main laying, &c., and Mr. J. H. Iliffe for the street services. The Water Committee of the Leicester Corporation carried out the main laying from the connection with the main of the Derwent Valley Water Board; the line consisting of 4360 lineal yards of 12-inch and 4050 lineal yards of 10-inch main, together with special works, valves, trenches, and main laying, at the cost of about £6700. The supply was turned on by the Chairman of the Water Committee of the Leicester Corporation on the 5th inst.

The whole of the work has been carried out under the supervision of Mr. Frederick Griffith, M.Inst.C.E., Water Engineer of the Leicester Corporation. The mains have been laid by workmen engaged direct by the Water Committee; and on this long length of main being tested, it was found that there was not a bad joint in it. This reflects great credit on the care and skill of Mr. N. B. Davis, Assoc.M.Inst.C.E., the Assistant-Engineer, and the workmen engaged in laying and jointing the pipes.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The meeting of the Eastern District of the Scottish Junior Gas Association at Kirkcaldy this afternoon was an exceedingly successful one, bearing out once more the wisdom of the policy of holding the meetings in different places. There was a very good attendance, and an excellent programme and well-balanced presentment of fare provided by both the senior and the junior elements in the gas industry. It was evident, from the rapt attention which was given to the address of Mr. W. Ewing, of Lochgelly, that his remarks were going home. Mr. Hutchinson's paper upon purifiers was a production so complete that its full effect can only be realized by study, and by comparison with handbooks.

Mr. W. R. Herring, who has been during his comparatively short period of office in Scotland a tower of strength to the gas industry in the North, retired from the scene of his labours in an interesting manner, tinged with dramatic effect, on Tuesday evening. He has done so much to improve the lot of the gas worker—in the physical nature of his surroundings (which at Granton are as paradise to the abyss when compared with the working conditions prevailing in many works, not all of which are either old or regarded as out of date), and on the financial side of the workers' employment in the satisfactory wages paid in the present and the pension which is in prospect—that it was only what was to be expected that an endeavour should be made to mark the workers' appreciation of Mr. Herring's care for them. The appreciation, as will be seen from the report on another page of the proceedings at Granton on Tuesday evening, took the form of a presentation of handsome silver mementoes. The workmen, to the number of 400, assembled in the Technical Office at Granton, under the genial chairmanship of their new chief, Mr. A. Masterton; and the evening was spent right blithely in song, recitation, and music, including bagpipe selections, interspersed with the necessary remarks attending the presentations to Mr. and Mrs. Herring and one or two toasts. I do not need to dilate upon the stately language with which Mr. Masterton prefaced his handing over of the gifts, further than to say that it was a universal acknowledgment that the task could not have been more befittingly performed. It was in Mr. Herring's words of thanks, and in the reminiscent observations in which he indulged, that the interests of the evening centred. Mr. Herring spoke under strong emotion. It was evident that he had, and has, Granton entwined round his being so completely that, although he has quitted its portals, he is still there in mind and in affection. There was, in his remarks, a deeper note than that of attachment to the works, to be found in the regard for his workpeople, which, it will be seen, was the leading topic of his address. The reciprocation of that regard, it was touching to observe, found expression on the part of the workmen, in their eagerness to shake hands with their departing chief. Those who saw the departing scene will not soon forget it. There was emotion on both sides—on the part of Mr. Herring, who was taking leave of a trusted band of workers, and on the part of the workers, who were parting with one who had consistently befriended them. Mr. Herring is no longer a gas manager. He has risen to a higher sphere of his profession, after doing good work in it. The Granton Gas-Works are not his only monument. He has left behind him a staff of workers the most contented that can be found anywhere; and he has closed a period of management which, to those under him, is full of kind recollections only. It is a significant fact, and a testimony to his ability and his goodness of heart, that now he has gone back to England, after thirteen years' service in Edinburgh, he has left in charge of the works, in almost every department of the manager's side of the undertaking, the gentlemen whom he found in office when he came from Huddersfield. He has worked all through with the staff of assistants which were selected by his predecessor. The staff have reason to be grateful to Mr. Herring; and I know they are. There is another class which have a great regard for Mr. Herring; and their regard is perhaps as great a tribute as that of any—I refer to the representatives of the Press. Mr. Herring was never so busy but what he could see a Press man;

and no Press representative ever left him with the feeling of disappointment. Other reflections might be indulged in, over a career which, if it has been short in these northern parts, has been brilliant; but enough has been written to indicate the feeling with which Mr. Herring is regarded among his now recent colleagues and acquaintances in Scotland. In Scotland he has done a great work; and in Scotland there is cherished, and will be cherished for long, the happiest recollections of him.

The county of Fife is, to all appearances, about to be, in the near future, the *El Dorado* of Scotland. It is on the southern shore of the county that the Rosyth Naval Base is being established, in connection with which, in the course of a few years, there will be a large population located, and much public money expended. But the principal wealth of the county will be found in the development of the coal trade. Great strides in this direction have already been made; and there is no reason to believe that a limit to these has been reached. This week it is announced that the Fife Coal Company are about to revive the coal industry at Valleyfield, to the west of Rosyth, by which, it is anticipated, a large town will be called into being. Of course, all this importation of population and capital means, among other things, that there will be a wide field for gas supply. It is more than likely that this view of the situation has occurred to the leaders of commercial communities within the area which will be the scene of the forthcoming appreciation; but so far, except in the case of the Corporation of Dunfermline, there is little appearance of forward anticipations being cherished. In the case of Dunfermline, it is two years since they obtained control of the lighting of Charlestown and Limekilns, on the seashore quite close to Rosyth. They are at present promoting a scheme for an extension of the burgh boundaries so large as to bring them down to the property of the Naval Base—a distance of several miles; and the latest intimation is that last night, at the request of the Town Council of Culross, Mr. T. Stewart, the Convener of the Dunfermline Gas Committee, attended a special meeting of the Council for the purpose of discussing a proposal to supply gas for public and private lighting in the burgh. The suggestion is that the Corporation should lay a main to Culross, and give a supply on the high-pressure system, as in the case of Limekilns and Charlestown. Mr. Stewart submitted information regarding the proposal; and an interchange of views took place. A very obvious advantage of the scheme, it is submitted, is that a large number of customers would be secured on the line of pipe, which would pass through Crossford, Cairneyhill, Torryburn, and Newmills. It is computed that ere long, if the scheme is carried through, the pipe would supply a population but little short of 20,000. There is no gas supply in Culross.

The Helensburgh Town Council last night agreed that those gas consumers outside the burgh who use a million cubic feet of gas a year and over shall be charged at the same rate as consumers inside the burgh—viz., 3s. 4d. per 1000 cubic feet, which is a reduction of 2½d.

The Dalkeith Gas Company have reduced the price of gas to all consumers from 3s. 10d. to 3s. 6d. per 1000 cubic feet.

The report of Mr. A. Gillespie, of Glasgow, to whom the Corporation of Arbroath recently remitted to value the whole works and plant at the gas-works, was submitted to the Gas Committee of the Town Council on Tuesday. Mr. Gillespie states the capital value of the works to be £64,000. He made a valuation of the works a number of years ago, when he placed the amount at £47,800. The increase since then is due to the many alterations and improvements that have been carried out in recent years.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *Nov.* 12.

Sulphate of Ammonia.

The market has continued to have a drooping tendency throughout the week, and the volume of business has been small, consumers for the most part pursuing a hand-to-mouth policy. Values have been fairly well maintained, however, by the fact of the parcels offered having been taken up by dealers in order to cover previous sales. Although in some instances small transactions are reported at slightly less money, the closing quotations can be taken as £12 18s. 9d. per ton f.o.b. Hull, £13 per ton f.o.b. Liverpool, and £13 per ton f.o.b. Leith. The forward position has become rather neglected; makers still maintaining their views, and buyers not being inclined to operate.

Nitrate of Soda.

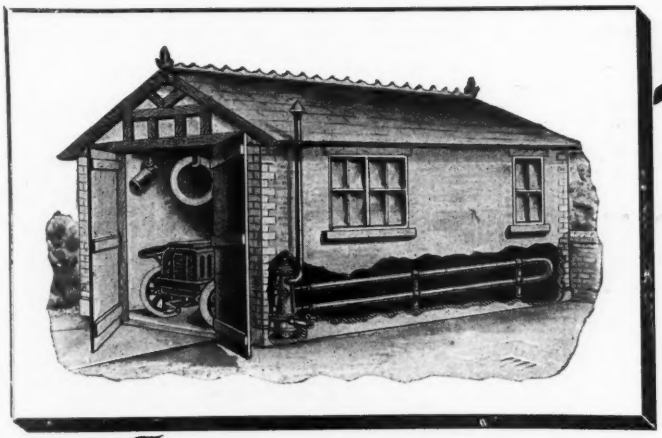
The market for this article is again without alteration in either tone or value, and to-day's prices are still 9s. 4½d. and 9s. 7½d. per cwt. for ordinary and refined qualities respectively, on spot.

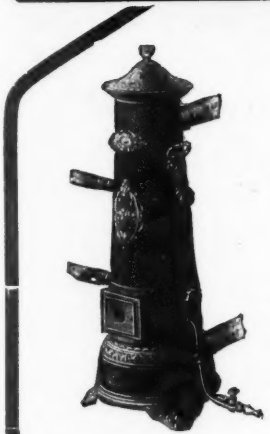
LONDON, *Nov.* 14.

Tar Products.

The markets for tar products have continued steady throughout the past week. Pitch has remained firm; and there have been one or two transactions during the week, which, however, have not had very much effect on the market, though it is understood that in some quarters purchases were made at a slightly lower price. Creosote is in about the same position, though the volume of new business is not very great. Benzols and naphthas are steady; but there has been no material increase in price. In crude carbolic, business has been done at a very much better price for both 50's and 60's; and as much as 1s. 1½d. has been refused on the east coast for delivery several months ahead.

The average values during the week were: Tar, 17s. to 20s. 9d. *ex* works. Pitch, London, 34s. to 34s. 6d.; east coast, 32s. 6d. to 33s. 6d; west coast, Clyde ports, 36s. 6d. to 37s. 6d., Manchester, 3 2s. to 33s. Liverpool, 32s. 6d. to 33s. 6d. Benzol, 90 per cent., casks included, London, 7½d. to 7¾d.; North, 7½d. to 7¾d.; 50-90 per cent., casks included, London, 7¾d. to 8d.; North, 7½d. to 7¾d. Toluol, casks included, London, 9d. to 9½d.; North, 9d. Crude naphtha, in bulk, London, 3¾d. to 4¼d.; North, 3½d. to 3¼d.; solvent naphtha, casks included, London, 11½d. to 1s. 0½d.; North, 11d. to 1s.; heavy naphtha, casks included, London, 11¾d. to 1s.; North, 10½d. to 11d. Creosote, in bulk, London,





Garage and Greenhouse Heating.

Since the reorganization of S. Clark & Co., now the Clark's Syphon Stove Company, Ltd., many notable and important improvements have been made. The introduction of a Gas Heater inside the Motor House is an epoch-making event which will be appreciated by Garage and Greenhouse owners and the enterprising Gas Manager.

Clark's "Motex" is designed so that all waste products are carried away through a flue to the external atmosphere, and the supply of air for combustion is obtained entirely from the outside. Fitted with air-tight door and inspection hole. Complete in itself, takes up little room, and being fitted with a bye-pass needs only once lighting, therefore, ready night or day for instant use.

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2⅜d. to 2½d.; North, 1⅞d. to 2¼d. Heavy oils, in bulk, 2⅜d. to 2½d. Carbolic acid, 60 per cent., casks included, east coast, 1s. 1½d.; west coast, 1s. 1d. Naphthalene, £4 10s. to £8 10s.; salts, 40s. to 45s., bags included. Anthracene, "A" quality, 1½d. to 1¾d. per unit, packages included and delivered.

Sulphate of Ammonia.

The market continues very firm; but in all quarters makers are asking higher prices, and they expect to realize these before many days are past. To-day actual Beckton is quoted at £12 12s. 6d. Outside London makes are £12 10s. In Hull, the price is £13 1s. 3d. to £13 2s. 6d.; Liverpool, £13 3s. 9d.; Leith, £13 5s.; and Middlesbrough, £13 2s. 6d.

Tar Products.

Representative manufacturers give the followirg as fair current values for the week ending Nov. 12.

Article.	Basis.	London.	North-East Coast.	East Coast, Yorks.	West Coast.	
					Liverpool.	Manchester.
Tar, crude	ton	21s.	18s.6d.–19s.	19s.6d.–21s.6d	18s.6d.–20s.6d.	18s.6d.–20s.6d.
Pitch	,,	35s.–36s.	32s. 6d.	32s. 6d.–33s.	34s.	33s. 6d.–34s.
Benzol, 50%	gal.	8¼d.–8½d.	7d.–7½d.	8d.	7½d.–7¾d.	7½d.–7¾d.
Benzol, 50/90 %	,,	8½d.	8d.–8½d.	9d.	8d.–8½d.	8d.–8½d.
Toluol, 50%	,,	9½d.	9d.	10d.	10d.	10d.
Crude naphtha, 50%	,,	—	3½d.	3½d.	3¼d.	3¼d.
Light oil, 50%	,,	—	2¾d.	3⅛d.–3⅜d.	3d.	3d.
Solvent naphtha, 90/160	,,	—	10½d.	10½d.	10½d.–11d.	11½d.–1s.
Heavy naphtha, 90/190	,,	—	11d.	11d.	11¼d.–1s.	11⅜d–1s.
Creosote in bulk	,,	2⅜d.	2¼d.	2d.	2d.–2¼d.	2d.–2⅛d.
Heavy oils	,,	3¼d.	2¼d.	2¼d.	2⅜d.	2⅜d.–3d.
Carbolic acid, 60's	,,	1s. 0¼d.	1s.–1s. 0¼d.	1s. 0¼d.	1s. 0¼d.–1s. 1d.	1s. 0¼d.–1s. 1d.
Naphthalene crude drained salts	ton	—	37s. 6d.	40s.–42s. 6d.	47s. 6d.	47s. 6d.–50s.
Do., pressed	,,	—	50s.	63s.	60s.	60s.
Do., whizzed	,,	80s.	—	—	70s.–72s. 6d.	70s.–75s.
Anthracene	unit	2d.	1⅝d.	1⅞d.	1¾d.	1¾d.

Prices are net, and they include the usual packages and delivery f.o.b., f.a.s., or f.o.r., as customary.

COAL TRADE REPORTS.

Northern Coal Trade.

The coal trade in the North has shown a little more activity—the unsettled condition of the Welsh mines having diverted a few orders to the North of England. In the steam coal trade, best Northumbrians are quoted from 9s. 8d. to 10s. per ton f.o.b. Second-class steams are 8s. 6d. per ton; and steam smalls vary from 5s. 6d. to 6s. 6d. The northern steam coal collieries have had rather fuller work—mainly from the cause named. In gas coal, there is a good demand, though a scarcity of steamers has limited the shipments a little. Durham gas coals are in full supply, and may be quoted at about 8s. 6d. to 9s. 6d. per ton f.o.b.; while for "Wear" specials, up to 10s. 4½d. is asked. There is now a full delivery of gas coals on the long contracts; and this must be expected to continue until after the turn of the year, as the great consumers will need to accumulate stocks for the weeks of largest use. There are inquiries for gas coal for delivery over next year at some of the Italian ports; but the prices offered do not tempt sellers to forward contracts at present. One or two small lots of gas coal have, however, been sold to Swedish ports. Coke is quiet. Gas coke is now more plentiful; but the price is steady at about 14s. 3d. per ton f.o.b. Tyne or Wear.

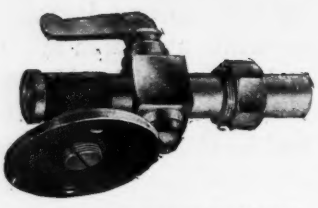
Scotch Coal Trade.

Trade moves slowly; even the struggle in South Wales having as yet had little effect in Scotland. There is, consequently, little change to record. The prices now quoted are: Ell, 8s. 9d. to 10s. per ton f.o.b. Glasgow; splint, 9s. 3d. to 9s. 6d.; and steam, 8s. 9d. to 9s. The shipments for the week amounted to 305,005 tons—a decrease of 5345 tons upon the preceding week, and of 18,437 tons upon the corresponding week last year. For the year to date, the total shipments have been 13 740,642 tons—an increase upon the corresponding period of 616,104 tons.

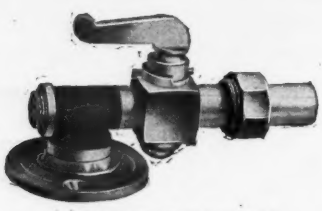
High-Pressure Gas Lighting in Lewisham High Road.—The Works Committee of the Deptford Borough Council have had under consideration a letter from the South Metropolitan Gas Company, applying for permission for the erection of 64 high-pressure gas-lamps on the footway of the eastern side of Lewisham High Road, between Nos. 119 and 249A. It is proposed to place 53 of the lamps on the kerb of the footway in a continuous line, about 22 feet apart; the remaining 11 being erected on the private forecourts abutting upon premises and shops. The scheme has been promoted by the Lewisham High Road Traders' Association; but the lamps when erected will be under the direct control of the Gas Company as to lighting and maintenance. The Company state that each lamp will have an approximate illuminating power of 1500 candles. The Committee have, subject to the usual sanction, given the Company the required permission under protective conditions.

Something New!

TWO-WAY GAS FIRE TAP.



USED AS STRAIGHT-WAY TAP.



USED AS ELBOW TAP.

The alteration is made by changing the position of Screwed Plug.

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Delivery of Coals at the Yeovil Gas-Works.

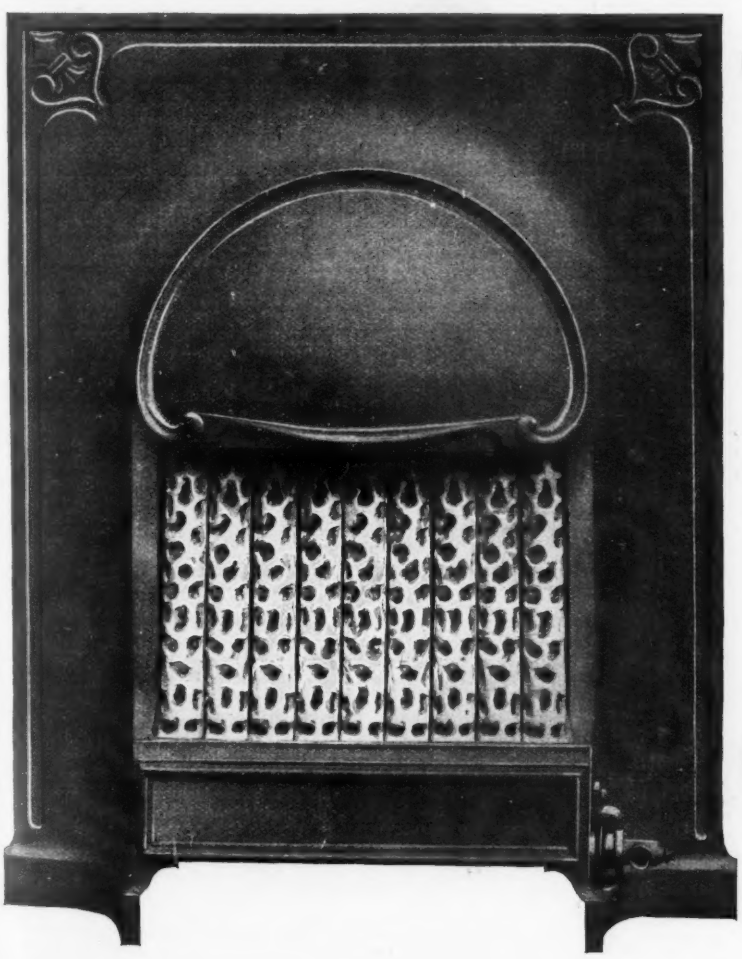
At last Wednesday's meeting of the Yeovil Town Council, the Chairman of the Gas Committee (Alderman Gould), in presenting his report, said there had been much correspondence between the Committee and the South-Western Railway Company with regard to the alleged delay in delivering waggons of coal to the gas-works. There had also been serious complaints from traders in the town; and some time ago it was said that there were 50 waggons on sidings at Yeovil Junction which could not be brought to the town station on account of lack of accommodation. The Manager of the Gas-Works (Mr. E. Howell) said he could not help thinking that the Railway Company were not treating the matter with seriousness. The accommodation at the South-Western goods station might have been sufficient ten years ago; but it was ridiculously inadequate now. Complaints from traders and manufacturers were general and emphatic, and, so far as the gas-works were concerned, the inconvenience and the increased cost of transit of materials were getting intolerable. Owing to the delay in the delivery of coal, they had had to make inroads into their reserve stocks; and it was possible that serious inconvenience in connection with the gas supply of the town might be caused. The Town Clerk (Mr. H. B. Batten) read correspondence between the Council and the Railway Company, who had replied that the matter was receiving attention. Letters were also read to the Council from trading firms complaining of delay. Mr. Matthews said that though there had been some criticism, no remedy had been suggested. The remedy lay with the Council. It was for them to consider what steps might be necessary; and they might make application to the Railway Commissioners. It was a very serious matter that the commerce of the town should be affected; and, in view of Mr. Howell's statement that the Company were treating the matter lightly, the Council must adopt strong methods. The Town Clerk suggested that if he wrote strongly to the Company perhaps the matter might be arranged in an amicable way; and there were many good reasons why this should be done. This course was ultimately adopted.

The New Issues of Capital at Tunbridge Wells and Redhill.—Tenders for the £2000 of consolidated "D" stock which the Directors of the Tunbridge Wells Gas Company recently invited in the "JOURNAL" have been considered by the Directors. We understand that applications for upwards of £5000 nominal of stock were sent in, the purchase money representing investments of nearly £11,000. The new issue of capital, which, under the sliding-scale, will be entitled to a dividend of 9¾ per cent. per annum, was allotted at an average price of 4¼ per cent.; something like 62 per cent. of the applicants failing to secure an investment. For the £5000 of ordinary "B" stock of the Redhill Gas Company recently advertised in the "JOURNAL," applications were received for £8515; and the average price realized was £102 1s. per £100. Both of these issues may be regarded as most satisfactory to the Companies.

Coke-Oven Gas at Caerphilly.—According to what transpired at the meeting of the Caerphilly Urban District Council last Tuesday, coke-oven gas is proving to be not so satisfactory as was attempted to be made out not very long ago. Mr. Harding complained that the gas in Caerphilly was defective. It appeared that a good deal of cheap gas was being bought from the Powell Duffryn Company and pumped down to Caerphilly from Hengoed. The penny-in-the-slot consumers complained that very often the pennyworth of gas did not last more than an hour; and this was not fair to them. It was decided that the gas should be tested. Mr. Tom Evans also complained of the quality of the gas at Nelson; and the Surveyor was instructed to make a test and report.

Quality of Devonport Gas.—At the meeting of the Devonport Town Council last Wednesday, Mr. Weeks complained of the low illuminating power of the gas, and asked what proportion of water gas was being supplied. Alderman Moon also commented on the poor quality of the gas. Alderman Tozer, the Chairman of the Gas Committee, said that at present they were using 27 per cent. water gas, which was in excess of what it should be. The Council had, however, recently sanctioned an expenditure of nearly £6000 for improvements and renewal of the plant; and when this work was carried out, they hoped to be able to supply a larger proportion of coal gas, and maintain the illuminating power at a higher standard. Speaking at a public meeting next day, Alderman Tozer said the gas undertaking was on a very sound financial basis, but the gas was not of the quality it should be. The Gas Committee were now spending a large sum on improvements, the result of which would be the production of a larger quantity of gas per ton of coal, and the use of a smaller percentage of water gas. He believed they would then get better illuminating power.

Increased Storage at the Hertfordshire Asylum Gas-Works.—The General Purposes Committee of the Hertfordshire County Council, having had their attention drawn to the inadequate storage capacity at the gas-works at the Three Counties' Asylum, consulted Messrs. W. R. & W. Phillips, of Luton, on the matter. The present storage is only 27,700 cubic feet, while the heaviest daily consumption is 55,000 cubic feet. The gas is used in connection with the lighting of the whole of the building and for the driving of the gas-engines, which are used for pumping the water required for domestic purposes and the fire system, and furnish motive power for all the machinery. Gas is also used for cooking purposes in the kitchens, and in stoves for heating the Asylum. Messrs. Phillips advised the erection of a new steel tank and a single-lift gasholder having a capacity of 30,000 cubic feet, arranged for conversion at some future time into a two-lift holder of a capacity of 61,000 cubic feet. The Visiting Committee of the Asylum, having considered Messrs. Phillips' report, decided to adopt their recommendation; and they instructed them to prepare plans and specifications and invite tenders for the work. The result is that the Committee have, subject to the usual sanction, resolved to accept the tender of Messrs. Robert Dempster and Sons, Limited, of Elland, which was the lowest submitted.



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10 in. Fire, Black & Fine Cast, **18/-**
Porcelain Enamel, **28/6.**

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French Gas Employees' Gratitude to a Manager.

The employees at the Amiens station of the European Gas Company have set a good example by publicly expressing their thanks to the Manager (M. Bertin) for an act of thoughtful consideration on his part. Owing to the high prices of provisions, and the consequent tax upon the resources of the employees, M. Bertin, unsolicited by them, put himself in communication with the Directors with the view of obtaining an increase in the men's remuneration. The request was favourably received, and granted, with the result that as from the 1st inst. the emoluments of the entire *personnel* have been substantially raised. In a signed paragraph inserted in a local paper without the knowledge of M. Bertin, the employees expressed their gratitude and devotion, and, in the name of their families, asked him to convey this expression to the General Manager (Mr. W. Williams) and Directors, and thank them for their kindness.

Sales of Stocks and Shares.

At the Mart, Tokenhouse Yard, E.C., last Tuesday, Messrs. A. & W. Richards sold, by order of the Directors, 400 additional ordinary £10 shares and £1000 of 4 per cent. perpetual debenture stock of the Lowestoft Water and Gas Company. The shares rank for a maximum dividend of 7 per cent.; but the last dividend on similar shares was at the rate of 5¼ per cent. per annum. They fetched from £10 5s. to £11 5s. apiece. The debenture stock was sold at £103 to £103 5s. per £100. On the same occasion, £300 of original stock of the City of Ely Gas Company, Limited, ranking for a maximum dividend of £10 per cent., but carrying 8 per cent., free of income-tax (equivalent to 8½ per cent., less tax), realized £160 to £161 per £100. A few fully-paid £10 shares in the Gas-Meter Company, Limited, on which a dividend at the rate of 10 per cent. was paid for the year ended the 30th of June last, fetched £13 10s. to £14 per share *cum div.* as from the 1st of July last. In accordance with the announcement in the "JOURNAL" for the 1st inst., Messrs. W. J. Villar and Co. sold on Monday last week, by order of the Directors, £3000 of 7⅞ per cent. stock of the Taunton Gas Company. It was part of a sum of £40,000 authorized by the Taunton Gas Act, 1897; and it fetched an average of £162 11s. 4d. per £100. At the Royal Hotel, Norwich, last Tuesday, Mr. S. Mealing Mills offered for sale a number of debentures, stocks, and shares in local undertakings. A few £20 shares in the British Gaslight Company, Limited, realized £43 10s. apiece. Some 3½ per cent. perpetual debenture stock of the Norwich Water Company, fetched £95 per £100; some £10 fully paid 5 per cent. preference shares in the same Company, £12 10s. each; and some £10 ordinary shares, £16, £16 2s. 6d., and £16 5s. each.

Oriental Gas Company, Limited.

At the ordinary general meeting of this Company to-morrow, the accounts to be presented for the half year ended June 30 last show that there was a moderate increase in the gas-rental compared with the figures for the preceding year. There was a considerable advance in the receipts for tar; but this was neutralized by a diminished yield from the sale of coke, the market for which commodity continues in a very depressed condition. The Directors report that the sanction of the Local (Bengal) Government has been given to the terms agreed between the Corporation of Calcutta and the Company for a new contract for the supply of gas to the public lamps for a period of twenty years from the 1st of May, 1911, at which date the existing contract will expire. In order to meet the greater requirements of the Corporation under the new contract, and to be in a position to satisfy a prospective expansion in the demands of other public bodies and of private consumers for gas, not only as an illuminant but for industrial and domestic purposes, the Company have been actively engaged during the year in main-laying operations and in augmenting and improving the manufacturing capacity of the works. This has involved considerable outlay, which has been met by the appropriation of £20,000 from the contingency fund. The Directors point out that the strength of the undertaking and its trading capabilities will be largely fortified by this expenditure. Further operations are being vigorously prosecuted and are expected to be completed early in 1911. The price of gas to the private consumers will be reduced by half a rupee (equal to 8d. English) per 1000 cubic feet, as from the taking of the December indices. The Directors recommend the payment of the usual dividend of 4½ per cent., free of income-tax, making a total dividend of 8 per cent. for the year. They express their regret at having to report the resignation of Mr. R. Hesketh Jones, who was a Director of the Company for seventeen years, and Chairman for the last ten years. Acting in accordance with the Company's Articles of Association, they have appointed Mr. Stanley H. Jones, M.Inst.C.E., to fill the vacancy thus caused.

Chester Water Supply.—The Chester Water Company propose to construct a reservoir for the storage of water previous to filtration. So far as the scheme has as yet been settled, the reservoir will be constructed upon land adjacent to the west side of Eaton Road, with a line of pipes leading from the present intake to the proposed reservoir, and thence to the water-works. The total capacity of the reservoir, which will be divided into four compartments, will be 76 million gallons. The Company propose to apply next session for parliamentary authority for the scheme.

Municipal Electric Wiring.—Opposition is being organized to a Bill which will be introduced next session to confer upon local authorities having electricity supply powers the statutory right to engage in the wiring of premises for electric light and in the sale of electrical apparatus and fittings. The measure is being promoted by the Incorporated Municipal Electrical Association—a body formed by municipal electrical engineers and members of municipal electricity committees. The main opposition comes from the Electrical Contractors' Association; and it is based on the contention that municipal wiring and sales departments will constitute unfair and unnecessary rate-aided competition with an established branch of retail trade.

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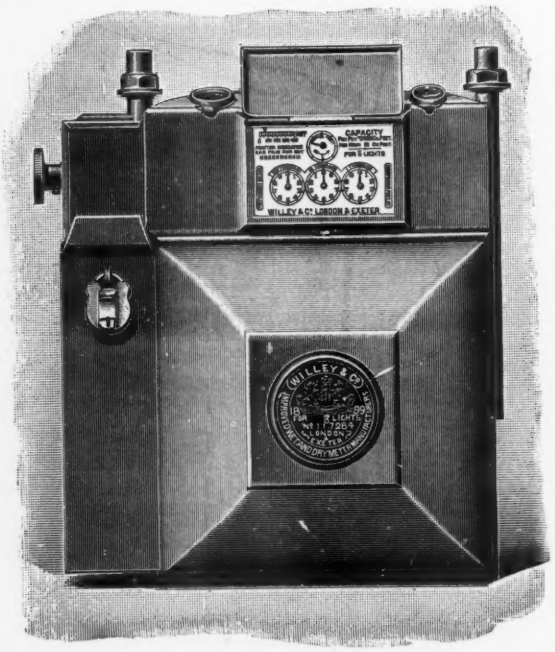

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D. M. NELSON & CO., 53, WATERLOO STREET, GLASGOW.

Value of Hertfordshire Gas and Water Undertakings.—The Rate Committee of the Hertfordshire County Council report that the total figure at which the gas and water undertakings stand in the existing county rate-books, is £96,105 gross and £65,505 rateable value. The result of a revaluation made by Messrs. H. Trustram Eve and W. G. Cooke is to raise these figures to £107,606 gross and £73,074 rateable—an increase of 11½ per cent. The properties of the Metropolitan Water Board have not been dealt with.

A Queen's Heavy Gas Bill.—According to a Central News telegram from Lisbon, in the "Pall Mall Gazette" last Friday, the "Seculo" had received information to the effect that the Gas Company had seized private property belonging to the Dowager Queen Maria Pia for payment of an indebtedness of £3200 for light. It was also reported that the Company had communicated with the dethroned King Manuel, asking whether he would desire to discharge this liability, or whether he preferred that the Royal property should be sold by auction.

Hastings Corporation and the Gas-Burner Bills.—In the notice last week of the proceedings at the meeting of the Hastings Town Council on the 4th inst., at which the accounts for the opposition to the Gas-Burner Bills were presented and passed for payment, it should have been mentioned that the Public Lighting Committee recommended that further opposition should be abandoned; and the fact that this was agreed to *nem. con.* seems to show that the Council are disinclined to continue what has been a costly (and apparently useless) fight. One speaker probably voiced the opinion of many of his colleagues when he said that they did not know the opposition would cost so much, or they would have let the other towns go their own way.

Wombwell Gas Undertaking.—The annual report on the Wombwell gas undertaking was submitted to a recent meeting of the Urban District Council, who considered it highly satisfactory. The gross profit on the year was £2835, which, after deducting repayments of principal and interest on loans amounting to £1557, left a net profit of £1278. The net profit the previous year was £876; and in the year before that, £110. A reduction in the price of gas of 3d. per 1000 cubic feet and the abolition of meter-rents were in force during the last two years. The working expenses showed a reduction of £433 on the previous year, though 1,807,000 cubic feet more gas were sold. During the year, 316 new consumers were added; the total consumers being 3583. Various additions to the plant are contemplated.

Alderman Gibson on Supporting Rates Out of Gas Profits.—In the course of an inquiry held at the Manchester Town Hall on Friday, by Mr. A. G. Drury, in respect of an application made to the Local Government Board by the Corporation for authority to borrow £30,000 for the purposes of the electricity supply undertaking, Alderman Gibson, the Chairman of the Gas Committee, was called on behalf of the Ratepayers' Association, whose representative (Mr. J. C. B. Percy) had adversely criticized the policy of the Electricity Department. He said that for many years the Gas Department had been practically subsidizing the rates—a policy he did not agree with. He agreed, however, with that of the Electricity Department; but since both belonged to the same Corporation, he contended they should both be treated alike.

The British Coalite Company announce that their Barking works, which were closed down some weeks ago, have been started again.

We have received from Messrs. John Russell and Co., Limited, of 145, Queen Victoria Street, E.C., their new catalogue of gas lighting fittings and accessories, which contains a selection of this season's designs in pendants, brackets, lamps, &c.

The Local Government Board have sanctioned several loans for the purposes of the gas undertaking of the Torquay Town Council—viz., £210 for a sulphate-house, £290 for sulphate plant, £1100 for mains and services, £2450 for meters (£150 for ordinary and £2300 for prepayment), and £300 for cookers.

A first and final dividend of 2¾d. in the pound has been declared in the bankrupt estate of John Robert Little, proprietor of gas-works, Burgh-le-Marsh, Lincolnshire; and a supplemental dividend of ⅜d. in the pound in that of the London Gas-Mantle Manufacturers, Limited, of 28, Fitzgerald Avenue, Mortlake.

The British Lighting Development Company, Limited, was registered with a capital of £1250 (1200 ordinary shares of £1 each, and 1000 deferred shares of 1s. each) to carry on the business of manufacturers of, and dealers in, gas fittings and appliances; also to acquire the business carried on by the British Lighting Development Company, &c.

One of the largest single orders ever placed with a gas-stove firm for an installation of cooking apparatus has been received by the Richmond Gas Stove and Meter Company, Limited. The apparatus, which includes a very great variety of the Company's manufactures, has been ordered by His Majesty's Office of Works for the new Money Order Office; and we learn that the total value of the order is approximately £1750.

At Stockport, some days ago, four children had a narrow escape from being asphyxiated. During the night, the supply of gas became exhausted; and one of the daughters, before going to work, placed a penny in the slot of the prepayment meter, not knowing that a tap in the room in which the four children were asleep was turned on. When the fact was discovered, as a result of the moaning of the children, they were all unconscious. One of them had to be taken to the infirmary, but all recovered in the course of a few hours.

We have received from the James Keith and Blackman Company Limited, a neat catalogue holder which they have had made for containing their numerous publications, and facilitating reference thereto. The catalogues are all of one size (7 in. by 4½ in.), in wrappers of different colours; and their titles are printed on white paper inside the lid of the holder, which has the appearance of a leather-bound book—the back being gilt lettered with the name of the Company and those of their specialities. A flap, closing with a catch, keeps the contents from falling out.

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A Luminous Flame Radiator, built on the sectional principle.

Supplied in various Finishes.

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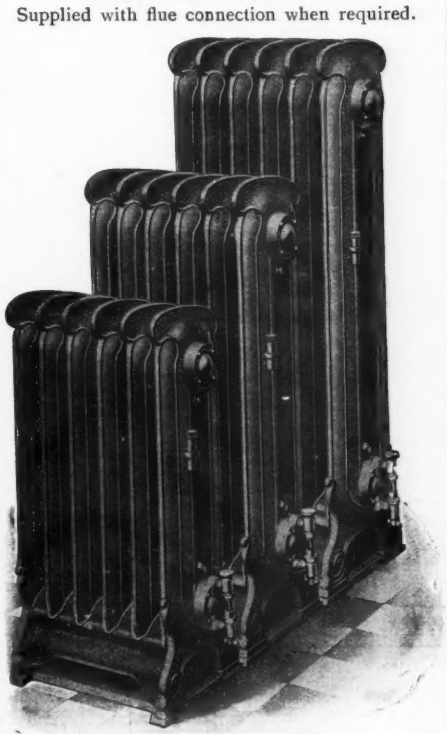

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Situations Vacant.

General Manager (Gas Engineers). No. 5313.
Draughtsman. No. 5315.
Draughtsmen (Junior and Senior). No. 5319
Working Manager (Midlothian). Applications to Messrs. Wishart and Sanderson, Edinburgh.
Traveller (Burners). No. 5316.
Accountant Clerk. No. 5317. Applications by Nov. 21.
Working Foreman Gas Fitter, &c. Shanklin (I. of W.) Gas Company.
Man for Maintenance Work. Ilfracombe Gas Company.
Foreman Stove and Meter Repairer. No. 5318.

Situations Wanted.

General Manager (Gas Fitting, &c., Trade). T. L. Cuttell, Stockton-on-Tees.
Distribution Inspector and Salesman (Home or Abroad). No. 5314.

Plant, &c. (Second-Hand), for Sale.

Experimental or Test Gasholder and Tank. Clayton, Son, and Co., Hunslet.

Stocks and Shares.

Barnet Gas and Water Company (by Auction). Dec. 6.
Bristol Gas Company (by Auction). Dec. 8.
Pinner Gas Company (by Auction). Nov. 22.
Southend Water Company (by Auction). Nov. 22 and Dec. 6.

TENDERS FOR

Gasholders, &c.

Dudley Gaslight Company. Tenders by Nov. 21.

Pipes, &c.

Rhondda Urban District Council. Tenders by Dec. 1.

Purifiers.

Dunedin (N.Z.) Corporation. Particulars of T. Cole and Son, Westminster. Tenders by Jan. 25.

Steel and Ironwork, &c., for Retort-Bench.

Sheffield Gaslight Company. Tenders by Dec. 6.

Sulphate of Ammonia Plant, &c.

Sutton-in-Ashfield Gas Department. Particulars of Messrs. Corbet Woodall and Son, Westminster. Tenders by Dec. 6.

NOTICES TO CORRESPONDENTS, ADVERTISERS, AND SUBSCRIBERS.

No notice can be taken of anonymous communications. Whatever is intended for insertion in the "JOURNAL" must be authenticated by the name and address of the writer; not necessarily for publication, but as a proof of good faith.

COPY FOR ADVERTISEMENTS for the "JOURNAL" should be received at the Office NOT LATER than TWELVE O'CLOCK NOON ON MONDAY, to ensure insertion in the following day's issue.

Orders for Alterations in, or stoppages of, PERMANENT ADVERTISEMENTS should be received by the FIRST POST on SATURDAY.

Wanted, For Sale, and Tender Advertisements, Six Lines and under, 3s.; each additional Line, 6d.

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LARGEST SALE OF ANY OXIDE.

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"VOLCANIC" FIRE CEMENT.
Resists 4500° Fahr. Best for GAS-WORKS.
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WE keep at our London premises (59, Farringdon Road) a large stock of all sizes for immediate delivery.
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SATURATORS and all LEAD and TIMBER WORK in Connection with Sulphate Plants.
We guarantee promptness, with efficiency for Repairs.
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GAS LIGHTING ENGINEERS AND CONTRACTORS,
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Are prepared to Supply
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SPECIALLY prepared for the Manufacture of SULPHATE OF AMMONIA.
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The Reliance Lubricating Oil Company, 19 & 20, Water Lane, Tower St., London, E.C. Agents wanted.

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First-Class men only need Apply.
Apply, by letter, giving Particulars of Training, present Employment, and Wages required to Frank C. Taylor, Engineer and Secretary.

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A LARGE Gas-Works in the North of England, with Large Extensions in progress, requires a GOOD DRAUGHTSMAN, well up in Gas-Works Practice. It is very essential that he possess a sound knowledge of Building Construction. Salary, £3 per week. Also a Capable JUNIOR DRAUGHTSMAN who is a neat Tracer, and Letterer. Salary 30s. per week.
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WANTED, by a Gas Company near London, a FOREMAN for Gas Stove and Meter Repair Shops. Applicants must have had Experience in this kind of work and thoroughly understand all branches, including the proper adjustment of Gas Apparatus of all descriptions.
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WANTED, a Senior Accountant Clerk, thoroughly conversant with Books and Accounts of a large Gas Undertaking (South of England). Shorthand an advantage but not a necessity. Accurate and quick at figures. Age not to exceed 35 Years.
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THE City Corporation of Dunedin, New Zealand, invite TENDERS for the Supply and Delivery at Dunedin of one Complete Set of PURIFIERS, consisting of Two Boxes, each 30 feet by 30 feet by 5 feet deep.
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Tenders are to be addressed to the Town Clerk, Dunedin, New Zealand, and to be received by him not later than the 25th of January, 1911.

SUTTON-IN-ASHFIELD URBAN DISTRICT COUNCIL.

GAS-WORKS EXTENSION.

TENDERS are invited for the Supply, Erection and Setting to Work of a SULPHATE OF AMMONIA PLANT, having a capacity of 20 Tons Liquor per diem, with all Accessories Complete, at the New Gas-Works.
Drawing, Specification and Form of Tender can be obtained from the Engineers, Messrs. Corbet Woodall and Son, of Palace Chambers, Bridge Street, Westminster, S.W., upon the payment (by Cheque only) of a deposit of £2 2s, which will be returned on receipt of a *bonâ-fide* Tender.
Tenders on the Form supplied are to be delivered not later than Ten a.m. on Tuesday, the 6th day of December, 1910, addressed to the undersigned and endorsed "Tender for Sulphate of Ammonia Plant."
The lowest or any Tender will not necessarily be accepted.

JOHN D. FIDLER,
Clerk to the Council.

Council Offices,
Sutton-in-Ashfield, Notts.

TOWN OF DUDLEY GASLIGHT COMPANY.

TENDERS FOR GASHOLDERS.

THE Directors of the above Company invite TENDERS for the Cutting Out of an existing SINGLE LIFT GASHOLDER, 100 feet diameter by 26 feet deep, with Guide Framing, and for the Supply and Erection of a TWO-LIFT GASHOLDER in existing Tank, at the Gas-Works, Dudley (Inner Lift 97 feet diameter by 26 feet deep; Outer Lift, 99 ft. 6 in. diameter by 26 feet deep), with STEEL GUIDE FRAMING Complete.
There are a limited number of Sets of (three) Prints, together with Copies of Specification, to be had on Application to the undersigned on payment of the sum of £1 1s. per Set, or Copies of Drawings and Specification may be taken at the Company's Offices, Gas-Works, Dudley.
Sealed Tenders, to be delivered on or before Twelve noon on Monday, the 21st day of November, 1910, addressed to the Chairman, Town of Dudley Gaslight Company, Gas Offices, Dudley, and endorsed "Tenders for Gasholders."
The Directors do not bind themselves to accept the lowest or any Tender.

T. E. STILLARD,
Secretary.

Gas-Offices, Gas-Works,
Dudley, Oct. 26, 1910.

TO ENGINEERS AND IRONFOUNDERS.

THE Directors of the Sheffield United Gaslight Company invite TENDERS for STEEL AND IRONWORK for Twelve Settings of Ten RETORTS, at their Neepsend Works, as follows:—

For the Supply and Delivery only of CAST-IRON BUCKSTAY SHOES, ASH PANS, AND FURNACE FITTINGS.

For the Supply and Erection of STEEL AND IRONWORK, consisting of Rolled Steel Joists, &c., forming Floors and Bench Framing.

For the Supply and Erection of STEEL AND IRONWORK in Hydraulic Mains, Ascension Pipes, Chequer Floor Plates, Gas and Tar Mains, &c.

For the Supply and Delivery only of 232 Self-Sealing RETORT MOUTHPIECES, 24½ in. by 16½ in. ⌂ shape.

Drawings may be seen and Specifications, with Forms of Tender and Quantities, obtained, on and after Nov. 17, on Application to the Engineer, Mr. J. W. Morrison, at the Company's Offices, Commercial Street, Sheffield.

The Directors do not bind themselves to accept the lowest or any Tender.

Sealed Tenders, endorsed, must be Delivered by post to Mr. Hanbury Thomas, Managing-Director, not later than the first post on Tuesday, the 6th day of December.

WM. HAMBY,
Secretary.

Commercial Street,
Sheffield, Nov. 10, 1910.

SALES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MESSRS. A. & W. RICHARDS beg to notify that their SALES BY AUCTION of NEW CAPITAL ISSUED UNDER PARLIAMENTARY POWERS, and of STOCKS and SHARES belonging to EXECUTORS and other PRIVATE OWNERS in LONDON, SUBURBAN, and PROVINCIAL GAS and WATER COMPANIES, take place PERIODICALLY at the Mart, TOKENHOUSE YARD, E.C.

Terms for Issuing New Capital, and also for including other Gas and Water Stocks and Shares in these Periodical Sales, will be forwarded on Application to MESSRS. A. & W. RICHARDS, at 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

PINNER GAS COMPANY, LIMITED.

NEW ISSUE OF 800 £5 "B" SHARES.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Nov. 22, at Two o'clock, in Lots.

Particulars of the AUCTIONEERS, 18, FINSBURY CIRCUS, E.C.

By order of the Executors of SOLOMON BLAIBERG, Esq., decd.

SOUTHEND WATER-WORKS COMPANY.

200 £10 NEW ORDINARY FIVE PER CENT. MAXIMUM SHARES.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Nov. 22, at Two o'clock, in Lots.

Particulars of the AUCTIONEERS, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

SOUTHEND WATER-WORKS COMPANY.

NEW ISSUE OF £5000 FOUR PER CENT. PERPETUAL DEBENTURE STOCK.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Dec. 6, at Two o'clock, in Lots.

Particulars of the AUCTIONEERS, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

BARNET DISTRICT GAS AND WATER COMPANY.

NEW ISSUE OF £10,000 "D" CAPITAL WATER STOCK.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Dec. 6, at Two o'clock, in Lots.

Particulars of the AUCTIONEERS, 18, FINSBURY CIRCUS, E.C.

THE BRISTOL GAS COMPANY.

GEO. NICHOLS, YOUNG, HUNT, ALDER, and CO. are instructed to SELL BY PUBLIC AUCTION, at their Sale-Room, 49, Broad Street, Bristol, on Thursday, the 8th day of Dec., 1910, at Three p.m. precisely, in Lots of £100 each, or less,

£15,000

FIVE PER CENT. MAXIMUM GENERAL CAPITAL STOCK, AND

£10,000

NEW DEBENTURE STOCK,

(Bearing *INTEREST AT THE RATE OF FOUR POUNDS PER CENTUM PER ANNUM*, payable Half-Yearly, in June and December),

OF AND IN

THE BRISTOL GAS COMPANY,

Issued by the Company under their Statutory Powers.

The Stocks will be Sold and Registered in the Books of the Company *FREE OF EVERY EXPENSE* to Purchasers thereof.

Full Particulars and Conditions of Sale may be obtained of the AUCTIONEERS, 49, Broad Street, BRISTOL; Mr. T. D. SIBLY, Solicitor, Exchange, BRISTOL; or of

JOHN PHILLIPS,
Secretary.

Chief Offices: Colston Street,
Bristol.

RHONDDA URBAN DISTRICT COUNCIL.
NEW WATER-WORKS.

MAIN THROUGH BLAENRHONDDA TUNNEL.

THE Rhondda Urban District Council are prepared to receive TENDERS for the Supply of about 675 Tons of CAST-IRON PIPES, 23 inches internal diameter, 12 feet long, together with about 25 Tons of BENDS, SPECIALS, and GRATINGS for same, all to be delivered at the North Dunraven Siding, Taff Vale Railway, Rhondda Branch.

A Copy of the Specification and Form of Tender, with a Schedule of Quantities, may be obtained, on and after the 9th day of November, 1910, at the Office of Mr. Joseph Vevers, the Engineer, the Water-Works Office, Treherbert, Rhondda, upon production of a receipt, signed by the Accountant of the Council, for the required deposit of Two Guineas, which deposit will be returned after the receipt of a *bond-fide* Tender, with all the Items in the Schedules Fully-Priced out, but will be Forfeited in case of withdrawal of Tender after Acceptance by the Council.

Sealed Tenders, addressed to the Chairman of the Water-Works Extension Committee, at the Council Offices, Pentre, Rhondda, endorsed "Tender for Cast-Iron Pipes, &c.," must be delivered at my Office not later than Ten a.m., on Thursday, the 1st day of December, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

Dated this 8th day of November, 1910.

W. P. NICHOLAS,
Clerk of the Council.

The Council Offices,
Pentre, Rhondda, Glam.

In Large Crown 8vo. Fully Illustrated. In Two Volumes.

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A Hand-Book on the Production, Purification, and Testing of Illuminating Gas, and the Assay of the Bye-Products of Gas Manufacture.

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Progress in the Design and Construction of Turbines Operated by Gases and Combustion.

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"Will be of considerable assistance to Gas Power Engineers."—*Gas World.*

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Made by
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One Man can fill a Sack quicker than Two Men without it.

UNBREAKABLE. PORTABLE.

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Rich in Illuminating Power and Yield of Gas. Above the Average in Weight and Quality of Coke.

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Best Gas Coal and Cannel, giving High Illuminating Power, Large Yield per ton, and reasonable in Price.
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Highest Cash Prices given for above.

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Manufacture and keep in Stock at their Works (also large Stock in London)

PIPES and CONNECTIONS, 1½ to 48 inches in diameter, and make and erect to order RETORTS, PURIFIERS, and TANKS, with or without planed joints, COLUMNS, GIRDERS, SPECIAL CASTINGS, &c., required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.

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MIRFIELD GAS COAL.

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VOL. CXI.

OF THE

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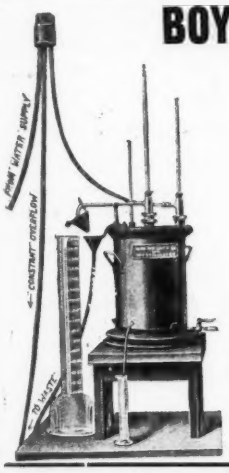

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Special Pressure and Pressure & Exhaust Registers.

For RETORT-HOUSE GOVERNORS.
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DETACHABLE CHAINS AND SPROCKET WHEELS.

HIGH-CLASS STEAM ENGINES. BEAM PUMPING-ENGINES, &c.

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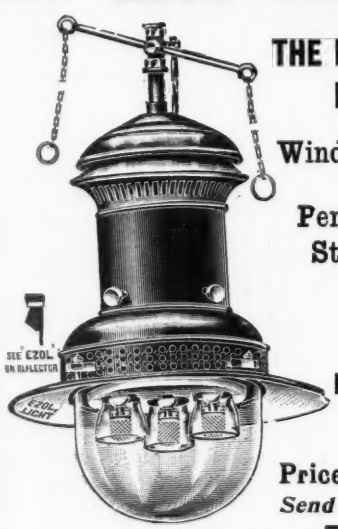

THE MOST ECONOMICAL LAMP EXTANT.

Wind, Rain, and Dust Proof.

Perfect Combustion.

Steady Brilliance.

125

C.P. PER BURNER

FOR GAS CONSUMPTION

3½ FT. PER HOUR.

Prices from **12s. 6d**

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— SPECIAL ADVANTAGES. —

The Bottom Plate is instantly removable with flues for cleaning purposes.

A Patent Gas Regulator which cannot become heated or jambed.

Flash Bye-Pass, improved, reliable.

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Made of Vitrified Steel with White Enamelled Reflectors, and is the model lamp for outdoor illumination.

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The Only Patent

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The Coke Problem Solved.

We want to tell you in as few words as possible what the making of Coalexld may mean to you.

Firstly —You require no license, no special plant, and no extra labour. This statement is quite definite.

Secondly—Small packages placed in each retort when charging, according to weight carbonized, is all that is required.

Thirdly —You can sell Coalexld at 30s. per ton.

Take in these three facts, and then consider the advantages of "Coalexld."

It is a smokeless fuel, giving great heat, extraordinarily free from sulphur, and containing no arsenic. Your tar and other residuals are richer and have an increased value, and it is unequalled for the Home, Blacksmiths' Shops, Bakeries, Hotel Grills, Hop Drying and Malting, and many other purposes.

Will You Give it a Trial?

If so, please send weight of charges, and full particulars will be sent.

Gas Manager No. 1.—Has a demand which exceeds his supply. In 1908 and 1909 his return from residuals (in addition to "Coalexld") greatly increased.

Gas Manager No. 2.—Finds a steady and increasing demand.

BLACKSMITH'S SHOP.

We tested it to-day, and were very pleased with the results. The smith made a fire with the whole lot that you sent, then took a bar of flat iron $1\frac{3}{4} \times \frac{5}{8}$, cut it in two, got them to a welding heat, and united them in a very successful manner without any further heating, and the weld was very clean. . . . Both the engineer, smith, and myself were very pleased that it did all that you claimed for it. The percentage of sulphur is very low indeed. W. D.

SUCTION GAS PLANT.

We find the Coalexld to be most excellent for use in suction gas plants. It gives good gas, is free from tar, and there is no trouble with clinker in the generators. From this point of view we are able to speak of it in the highest terms, and we will have every confidence in recommending your Coalexld for use in suction gas plants. N. G. E. Co., Ltd.

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We have given your Coalexld a thorough test on our Motor Lorry, and find it very satisfactory, being free from smoke, clinker and sulphur. R. F. H.

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We have been using "Coalexld" in the grill room of this hotel for some months, and we find it much better than coke, and excellent in every way.

I get a longer bright fire from "Coalexld" than from coal, and my coal bill last winter was reduced nearly one-half, and I have made arrangements for a full supply for the coming winter. I find for cooking purposes it is a great success.

ANTHRACITE STOVES.

Please send us another 10 cwts. of Coalexld. We have given it a good test in our Anthracite Stoves, and find it answers remarkably well. It is hot, clean and economical. It is free from smoke, soot, and sulphur. P. & S.

FORGE.

Kindly send another load. I have been using it for the last four months in my works for the Smiths' Fires, and it has given the greatest satisfaction. It has effected a saving in my fuel bill of 9s. per ton, which is a considerable sum by the end of the year. J. S.

ENGINEERING WORKS.

Having used for some time Coalexld, I have much pleasure in informing you that it has given the greatest satisfaction. We have a bright, clear fire, more heat, no smoke, soot, or sulphur; also a considerable saving in cost. I use it both at my engineering works at Bath Street, and at home. J. P. H.

MANUFACTURERS.

We find it excellent for heating purposes. We have previously had some trouble in getting up the temperature with our heating apparatus, but since using Coalexld we have had the greatest satisfaction. J. S. & Co.

CAFE AND RESTAURANT.

Please forward one load of Coalexld. I have been using it for the last six months with excellent results. It being free from smoke, soot, and sulphur, makes it a perfect fuel for my business as Caterer and Confectioner. It gives great heat, slow combustion, and great saving in cost. W. S.

These Testimonials were, in some cases, addressed to us, and in other cases to the gas managers above mentioned.

Coalexld Limited, Lancaster.

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MOST IMPORTANT!

Latest Development:

600 C.P. LOW PRESSURE LAMP.

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GAS REGULATION on the TOP of the LAMP.

All Goods are unapproachable for economy and durability.

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Every Genuine Glenboig Brick, Block, Gas-Retort, &c., is legibly stamped with one or other of the Glenboig Company's Registered Trade Marks, as here shown.

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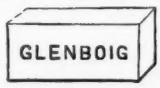

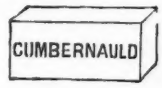

The Glenboig Trade Marks are imitated, and the Glenboig Name unfairly used by Makers of a lower Class of Goods, which, when sold under their own name, command much lower prices.
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The GLENBOIG BRICKS, BLOCKS, AND RETORTS combine, in the highest degree, the qualities of not melting, and not splitting, when subjected to the highest heats and most sudden changes of temperature, and are, in consequence, found to be economical, even in districts where the local bricks can be had at half the price.

Undernoted we give a Table of Analysis and Physical Characteristics of a sample of Glenboig Fire-Clay by J. T. Norman, London; and, in submitting a report from a responsible and reliable public analyst, we would here draw attention to the unreliable character of some recently published analyses where a manufacturer selects not only his own samples, but also those of his competitor, and has them treated by a private analyst. SUCH STATEMENTS ARE ALTOGETHER UNTRUSTWORTHY.

ANALYSIS OF GLENBOIG FIRE-CLAY.

By JOHN T. NORMAN, Esq., F.C.S., &c., The City Central Laboratory, LONDON.

THE GLENBOIG UNION FIRE-CLAY CO., LTD., GLENBOIG, SCOTLAND.

23, Leadenhall Street,
London, E.C., September 21st, 1909.

Dear Sirs,

I have completed the investigation of the samples of Clay received from you on the 10th inst., and now beg to report the results.

CHEMICAL ANALYSIS.

	Raw.	Fired.
Silica, free	3·03	3·49
Silica, combined	43·20	49·77
Alumina	36·55	42·10
Ferric oxide	1·80	2·08
Titanic oxide	1·30	1·50
Lime	trace	trace
Magnesia	trace	trace
Alkaline oxides	trace	trace
Sulphates as trioxides	0·92	1·06
Loss on Ignition	13·20	—
	100·00	100·00

PHYSICAL RESULTS.

Density	2·65
Volume weight	1·90
Porosity	15·4 %
Linear shrinkage at 100° C.	3·70 %
,, ,, ,, 1050° C.	4·76 %
,, ,, Total	8·46 %
Volume shrinkage at 100° C.	10·7 %
,, ,, ,, 1050° C.	12·6 %
,, ,, Total	23·3 %
Plasticity	20·0 %
Fire Stability	1850° C. equiv. 3362° F. (SEGER CONE 36.) (New Scale CONE 38.)

(Signed) J. T. NORMAN.

This Clay is remarkable for its high percentage of Alumina and for the almost complete absence of ingredients tending to lower the refractory properties; its fire stability is extremely high. For some years past I have been urging clients who are working the Clays of the Coal Measures to search for such a material, but you are the first to discover a supply. The possession of this Clay places you in a unique position amongst the manufacturers of refractory goods throughout the world, and I have no doubt will, if duly exploited, enable you to drive out of the market the large quantities of foreign fire-bricks which are being poured into this country for use in the construction of bye-product ovens and for other purposes.—I am, yours faithfully,

JOHN T. NORMAN.

STEEL SCOOPS
FOR
RETORT CHARGING.
Scoops supplied with or without handles, and of any dimensions or shape required.

HENRY SYKES, Ltd., Engineers,
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WILSON CARTER & PEARSON,
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Gas, Steam, and other Fuel for Home and Export.
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Petrol-Air Gas gives a most brilliant Light by Mantle.

PETROL GAS TURBINE GENERATORS PAY THEIR WHOLE COST

DURING ONE MONTH'S RUNNING IN WINTER.

The Gas is made cold, they are a splendid "Stand-By" to meet Fogs, or shortage of Gasholder capacity.

INQUIRIES INVITED NOW, FOR NEXT SEASON.

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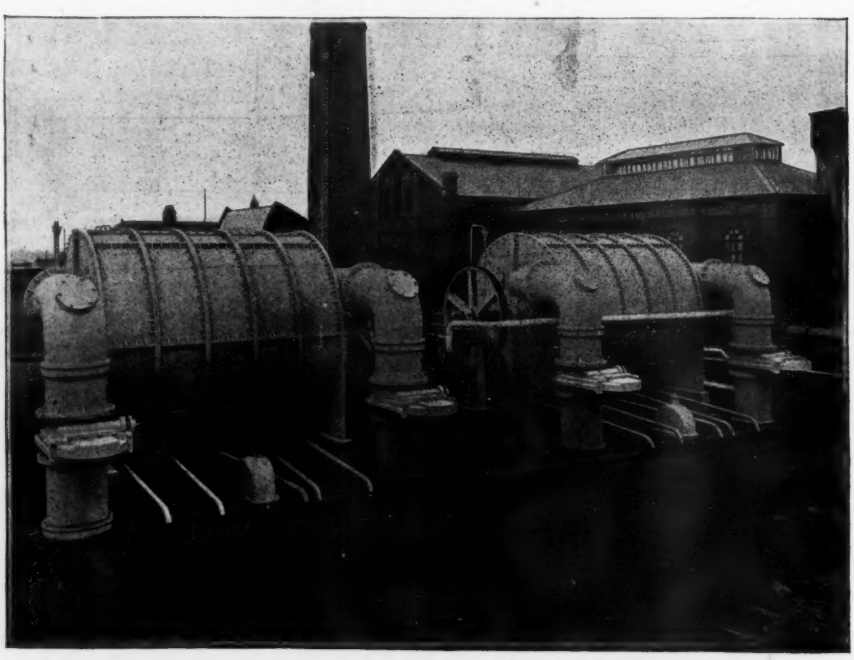
THE WHESSOE FOUNDRY CO., LTD.

Works: DARLINGTON.

LARGE AREA OF WASHING SURFACE.

REMOVAL OF THE WHOLE OF THE AMMONIA AND A LARGE PERCENTAGE OF CO_2 AND SH_2.



SLIP OF GAS IMPOSSIBLE OWING TO OUR PATENT TELESCOPIC SLIDING JOINT

BUNDLES EASILY ACCESSIBLE FOR CLEANING.

"Whessoe" Twin Rotary Washer-Scrubber (Patent No. 24,110 of 1903). **Combined capacity 3,000,000 cub. ft. per diem,** as supplied to The Walker and Wallsend Gas Company, Newcastle-on-Tyne.

London Office: 106, CANNON STREET, E.C.

Welsbach
LIGHT
Inverted Arc Lamp, Fig. 623.

Storm Proof—
For Exterior Lighting.

Welsbach-Kern
(Patent) Inverted System

BRITISH MADE.

BRITISH MADE.

Height over all.

1-light . . .	1 ft. 8 ins.
2-light . . .	2 ft. 4 ins.
3-light . . .	2 ft. 4 ins.
4-light . . .	2 ft. 7 ins.

Width over all.

1-light . . .	1 ft. 1 in.
2-light . . .	1 ft. 5 ins.
3-light . . .	1 ft. 5 ins.
4-light . . .	1 ft. 8 ins.

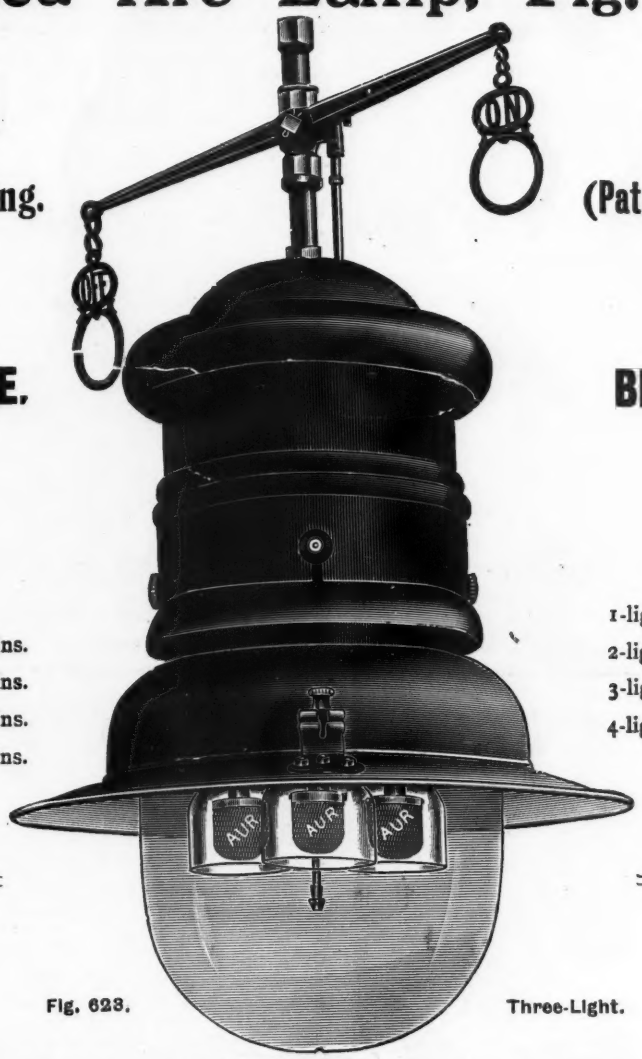


Fig. 623. Three-Light.

ENAMELLED Green Steel Casing, fitted with Welsbach-Kern Inverted Burners, Gas and Air Regulators operated from outside. Sliding Door to give access to Burners for cleaning purposes. Fitted with Magnesia Nozzles, Welsbach Mantles, and Glass Mantle Protectors. Complete as shown. Highly efficient and regenerative.

	Gas per hour.	*C.P.*	*Steel.*	*Copper Case.*		*Gas per hour.*	*C.P.*	*Steel.*	*Copper Case.*
1-light	4 feet	125	**30/-**	**5/-** extra.	3-light	12 feet	400	**52/6**	**6/-** extra.
2-light	8 feet	260	**47/6**	**6/-** extra.	4-light	16 feet	550	**72/6**	**9/-** extra.

All on or off, or One light on and the rest off, **7/6** per Lamp extra. Cup and Ball, **3/6** per Lamp extra.

RENEWALS.

Glass Mantle Protectors (Fig. 623) **3/4½** per dozen, or in case lots of 5 gross, **33/-** per gross.

	1-Light.	*2-Light.*	*3-Light.*	*4-Light.*
Clear Glass Globes, each	**2/3**	**5/9**	**5/9**	**9/-**
" " " In Case lots per dozen.	**19/6**	**57/9**	**57/9**	**93/-**
Case contains . .	*80*	*18*	*18*	*12*

	1-Light.	*2-Light.*	*3-Light.*	*4-Light.*
Wired Globes, extra each	**2/-**	**2/-**	**2/9**	**3/6**
Parabolic Reflector, extra "	**3/6**	**6/-**	**7/6**	Not made

Welsbach Mantles, **4½d.** each, or **4s. 3d.** per dozen subject as usual.

The Welsbach Mantles for Upright lighting are "C," "CX," and "Plaissetty," price **4½d.** each.

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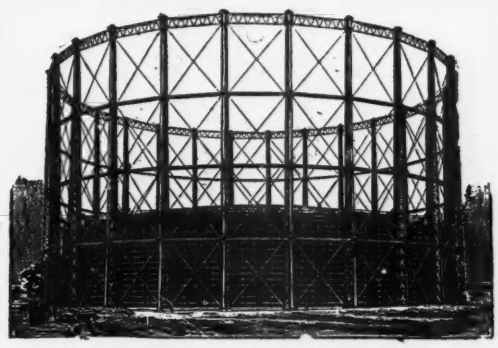

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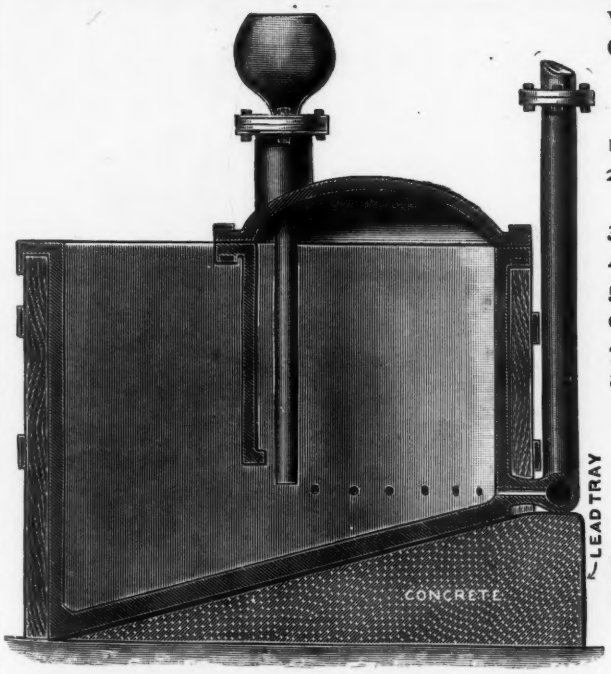

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6. **No incrustation.**
7. **No renewals of Cracker Pipe.**
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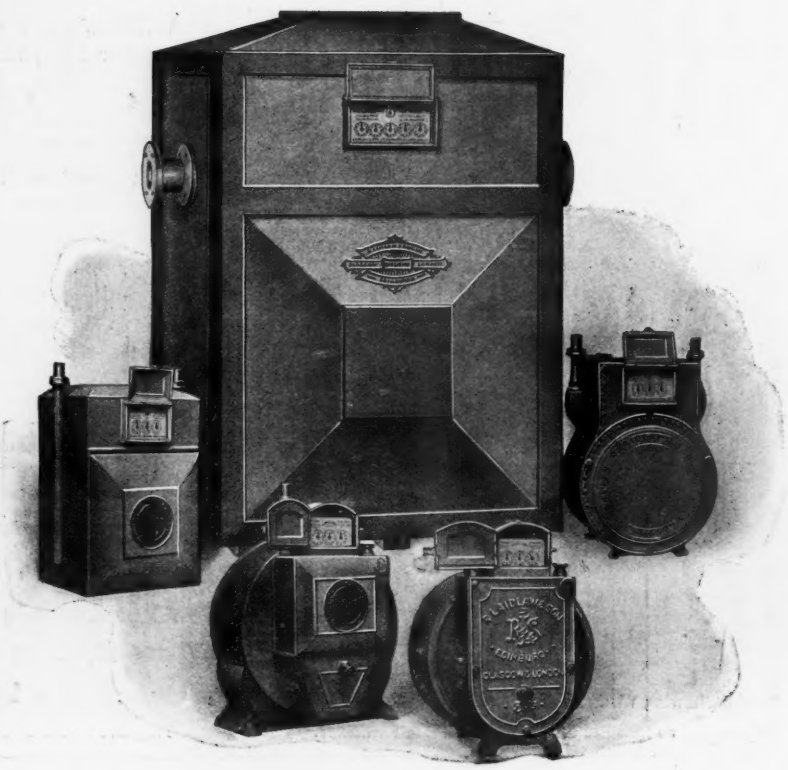

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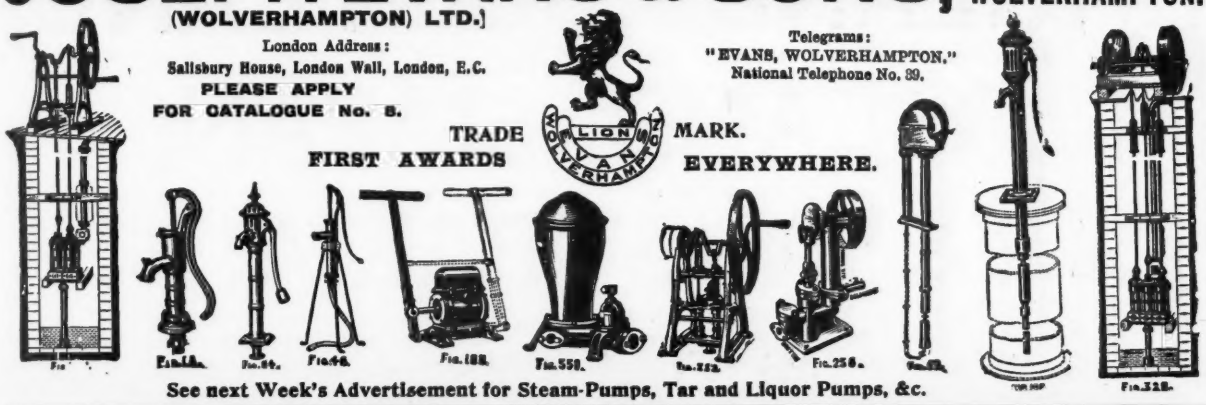

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